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Raghuram Rajan
Rodney Ramcharan

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ABSTRACT

The local availability of credit shaped whether, and how, farmers adapted to the long 1950s US drought. Investment in irrigation increased substantially more in drought-exposed areas with greater access to bank finance. Overall, these areas suffered significantly less population decline, both in the short-and long term. Thus, enhancing local access to finance can enable communities to adapt to large adverse climatic shocks, limiting outmigration.

Raghuram Rajan
Booth School of Business
University of Chicago
5807 South Woodlawn Avenue
Chicago, IL 60637
and NBER
raghuram.rajan@ChicagoBooth.edu

Rodney Ramcharan
University of Southern California
rramchar@marshall.usc.edu

As mitigation efforts lag, the world heats up, and climate volatility increases, the issue of climate adaptation becomes important. What factors can help a population adapt to adverse climate shocks? Can these factors affect long range outcomes? To answer these questions, we examine the long 1950s US drought, the second most severe drought to affect the US at the time (after the "Dustbowl" during the Great Depression). Despite its prolonged duration, the drought was not a persistent change in weather. Rainfall patterns in the areas most severely affected were not qualitatively different from unaffected areas before the drought, and by the 1960s, familiar weather patterns returned. Prima facie, there was a case for people to adapt to the weather shock rather than migrate permanently. Our focus is on whether access to bank finance facilitated adaptation and influenced long run demographics.

Emigration is the obvious response of a population to a prolonged drought if the population cannot adapt, even if the shock is not permanent (see, for example, Bohra-Mishra, Oppenheimer et al. (2014), Hornbeck (2012, 2022), and Long and Siu (2016)). However, adaptation, for example through irrigation, can weather-proof livelihoods and stave off the need to emigrate. Adaptation can even promote immigration, typically of younger, able bodied migrants, from other drought-hit areas that do not adapt. Adaptation often entails the adoption of new technologies and capital investment and is obviously supported by the greater availability of financing.

We find that droughts do induce migration, affecting demographics over the medium and long term. Specifically, population trends diverged between counties as the drought set in (around 1947 in the earliest hit areas). The population in 1960 is about 4.5 percent lower in drought exposed counties relative to the 1950 base year. This effect doubles to around 9.4 percent in 1970. Population losses then slow during the 1970s, so that the population in 1980 is about 11.7 percent lower on average among drought exposed counties compared to if these counties were not otherwise exposed to the drought.

The evidence also suggests that access to finance shaped the demographic impact of the drought. Among counties above the 75th percentile of 1950 loans per capita (a measure of credit availability), drought exposure is associated with a 5.6 percentage point decline in population by 1980 (p-value=0.12). But for those counties in the bottom quartile of credit availability, population is about 18.2 percent (p-value<0.01) lower relative to if these counties did not experience a drought.

While we establish these results after including a large set of controls, our measures of credit availability could well proxy for other factors that might ease adaptation and retard outmigration, or they may be directly positively correlated with immigration. To better identify the effects of credit availability, we first point to regulatory differences across states that might plausibly affect credit availability without being correlated with other factors that drive adaptation. This helps identification. Second, we examine the mechanism through which credit availability affects adaptation, specifically, through investment in irrigation. If differences in credit availability driven by regulation affect differences in adaptation investment, we have much stronger evidence of causality.

In the United States in the 1950s, some states allowed their banks to open branches within state, while other states did not permit bank branching and forced every bank to remain a single "unit" bank. Inter-state branching was not allowed. Studies find that, if anything, branch banking states were underbanked relative to unit banking states in terms of access to banking offices over the period of our study (see Horvitz and Shull (1964), Jacobs (1965), Pakonen (1969)). However, an extensive literature also documents the lower ability of unit banks to survive distress during the Depression (see Calomiris (2000), Michener (2005), and Wheelock (1995)).

The lower resilience of unit banks in times of widespread calamity is understandable. Unit banks in drought-hit areas would have a much greater concentration of impaired loans than the typically more-diversified branch banks, which would likely have some part of their branch network outside drought-affected areas. It is not even clear that unit banks that lent more in the past would be able to lend more in the drought; in drought affected areas, unit banks with greater 1950 loans per capita would have greater loan losses, which would hurt their capital and constrain their subsequent lending, offsetting somewhat their natural propensity to lend more. Branch banks would also likely be able to draw deposits from unimpaired areas to lend into drought-hit areas, something a unit bank located in a drought-exposed area would not be able to do easily.

Using bank-level data, we indeed verify that during the drought, loan growth in counties on the unit banking side of a state border is significantly lower than credit growth in similar counties on the branch banking side of the same border. Thus whether a state mandates unit banking or allows branch banking modulates how proxies for credit availability, such as the 1950 loans per capita, translate into actual credit availability during the drought.

We next turn to adaptation investment prompted by the drought. Perhaps its most important form was investment in irrigation (Leonard and Libecap 2019, Cooley and Smith 2022). And center pivot irrigation systems, first patented in 1952, were an important new technology that allowed farmers to irrigate using groundwater and boosted agricultural production in arid areas in the 1950s.[1] Importantly, we have data every 80 days on the depth of the underlying aquifer in about 106,000 water wells between 1950 and 1970 across the US. An increase in the depth of a well is a measure of aquifer discharge, and hence of investment in irrigation facilities.

We find that well depth increased sharply in drought exposed areas where the proxies for access to finance are high relative to drought exposed areas where the proxies are low (suggesting investment in deeper, and more, wells in the former areas). We also find that within one year after normal rainfall returned, these differences in aquifer discharge vanish, connecting access to finance, the timing of the drought, and adaptation through ground-water mining. Importantly, these effects are seen in counties in states that permit branch banking but are significantly muted in counties in states that mandated unit banking. We thereby draw a direct line between drought exposure, credit access, and the shift towards ground water irrigation-based agriculture. We obtain a similar result at the extensive margin, showing that the number of new wells increased more in drought exposed counties with greater credit access.

As might be expected given the above results, we also find that the increase in irrigated acres as well as the output per farm is higher in counties with greater credit availability. Because adaptation preserved local livelihoods, we find greater immigration into such counties, higher birth rates (because fewer of the fertile working age population leave, and more enter from elsewhere), lower death rates, and a higher local population over the long run. Finally, we also find evidence of spillover effects -- that the plentiful availability of credit in nearby towns is associated with lower population growth in a town, especially when the town itself has relatively low credit availability.

These findings have implications for policy. Given the growing concern that mitigation efforts will be insufficient to prevent climatic catastrophes from increasing in frequency and impact, adaptation has become an important goal of climate policy. Our findings then suggest that one

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[1] In drought affected Nebraska, the number of such systems increased from about a dozen in 1952 to around 10,000 by 1954--https://www.smithsonianmag.com/innovation/how-center-pivot-irrigation-brought-dust-bowl-back-to-life-180970243/--accessed on 7/26/2022 and Opie, Miller and Archer (2018).

way to help poor countries, which are most deeply affected by climate change (in part because they are so dependent on agriculture and in part because they are in hotter, more vulnerable regions), is to improve their people's access to finance, especially when physical adaptation is possible within the local community. An element of improving access is to support local financial institutions with more funding, another is to ensure that they are sufficiently diversified across regions and sectors so that they can survive the initial impact of the climate catastrophe while remaining healthy enough to be able to channel funds to support the adaptation effort (unlike the unit banks in our study).

Adaptation can help limit the extent of climate-induced migration, which our evidence suggests is typically to unaffected parts of the world, or to parts of the world that have the access to financing to implement adaptation measures. With this in mind, developed country policymakers who worry about potentially uncontrollable migration to their countries should think about how their policies can help improve access to financing in climate-affected countries. Also, while financial regulators need to calibrate carefully the possible risks to the banking system from climate-related losses, which would suggest less lending to climate sensitive areas and sectors, this needs to be set against the benefits of credit access in facilitating adaptation and innovation.

This paper builds on a rich literature that uses droughts and other climate shocks to evaluate predictions from economic models (Ramcharan (2007)). Hornbeck (2012) examines soil erosion during the Dust Bowl, and its effects on migration. Hornbeck does ask whether access to finance (as proxied for by the number of banks in 1928) allows more soil-eroded counties to adjust their mix of agricultural activities faster, and finds mixed results – consistent with the limited results he finds on adaptation. He does not examine the relationship between access to finance and migration. Turning to papers that focus more directly on credit supply, Cortes and Strahan (2017) study how multi-market banks respond to a variety of natural disasters, and find they increase lending in affected areas, but reduce lending to unaffected areas, especially ones peripheral to the bank's core locations. Cortes (2014) examines the rebuilding process after a natural disaster, and finds that areas with a one standard deviation more local deposits experience between 1 to 2% less employment loss for young and small firms. Morse (2011) finds that in areas served by payday lenders, poor residents face fewer foreclosures following natural disasters. Recent work by Bellon, LaPoint et al. (2024) shows that some government programs that relax financial constraints can induce homeowners to invest in projects that improve the climate resiliency of their home. Berg and Schrader (2012) use volcanic eruptions in Ecuador as an exogenous shock to credit demand, and find those firms with stronger bank relationships have more access to credit. Taken together, these papers suggest access to credit helps areas affected by natural disasters to cope better and can improve the resilience of the local economy.

Like Hornbeck (2012), our paper focuses on a climatic event with long term implications for the viability of a key economic activity (agriculture) in the area. Our outcome measure, population growth over the short and long run, reflects the failure to preserve livelihoods or create new ones – a central concern for climate adaptation. In contrast, many of the aforementioned papers focus on the actual damage by disasters to the local area and its repair, not on whether the long run viability of existing livelihoods is fundamentally altered. So in those papers, credit (for rebuilding or repair), investment, or short term unemployment are the appropriate outcome measures given the nature of the shocks. For us, they are only intermediate measures, which help us understand how adaptation takes place.

Perhaps most closely related is Albert, Bustos, and Ponticelli (2023), who examine the effects of changes in climate in Brazil on capital and labor reallocation in affected areas. While they examine short term annual shocks (where finance helps producers weather low cash flows and consumers to smooth consumption) and long term shocks over decades (where capital and labor reallocation are warranted), unlike us they do not focus on non-persistent shocks over the medium term where adaptation investment is critical. Albert et al. (2023) find that financial integration helps local communities in the face of short term shocks but hurts them when shocks are more permanent, as capital flees all sectors, not just agriculture. In contrast, we find that the local availability of finance helps adaptation investment, and limits population loss.

Section 1 of this paper develops the main hypothesis and describes the data, while Section 2 presents the basic results. Section 3 focuses on identification. Section 4 studies the broader effects of adaptation, including on population dynamics. We study spillover effects of nearby financing in section 5, and conclude with implications in section 6.

1. Hypothesis and Data

1.1. Droughts as adverse shocks

Technically, droughts are prolonged exogenous interruptions in rainfall that disrupt agricultural production and broader economic activity. An empirical setting using droughts is thus a useful laboratory to study the role of access to credit in shaping an economy's long run adjustment to an adverse shock.

To this end, we focus on the "1950s" drought, which began in the late 1940s (as early as 1947 in some areas) and lasted through 1957 in many areas. This drought was the second most severe drought of the 20th century after the "Dustbowl" of the 1930s (July 1928-May 1942), and remains the third most severe drought to affect the continental US since 1895—the 2012 drought became the most severe drought since 1895 (see Heim (2017)). Unlike the Dustbowl, which occurred during the Depression, the 1950s drought did not occur at a time of general economic distress, and so we can tease out the specific effects of the drought without the broader confounding factors of a depression. Moreover, unlike more recent droughts, enough time has passed since the 1950s drought to examine its longer run consequences. Also, farm output accounted for much more economic activity in 1950 than in 2012 (farm output was 10.4% of US GDP in 1950, with a significantly greater presence in interior rural areas, and was only 2.4% in 2012). Our results can thus help inform discussions of how large-scale climatic disruption might affect modern developing economies, which typically have large agricultural sectors.

Figure A1.1 in the Internet Appendix (IA) shows the time series intensity of droughts, plotting the percent of the continental US land area classified as in drought from 1900-2014. In terms of land area affected, the Dustbowl is larger than the 1950s drought; the peak coverage of the Dustbowl was 80 percent of the US land area versus 61% for the 1950s drought. The 1950s drought was however more persistent, with about 60 percent of the country's land area remaining in drought through much of the 1950s. IA Figure A1.2 shows the spatial variation in drought intensity across the continental US for both the Dustbowl and 1950s droughts. There is only a modest spatial overlap between the two drought episodes. While the Dustbowl mainly affected the upper-Midwest and plain states, the 1950s drought was particularly severe in the southern regions of the United States. In Texas, for example, the 1950s was the most arid period in the modern era.

In this paper, we use county-level Standard Precipitation Indices (SPI) from the National Oceanic and Atmospheric Administration (NOAA) that use a 9 month time scale to measure the percent of a county's land area that is in exceptional drought, defined as "exceptional and widespread crop/pasture losses" and "shortages of water in reservoirs, streams and wells creating water emergencies".[2] These data are available monthly from 1895 through the current period. The main drought metric used in the analysis is the average percent of a county's land area in exceptional drought over the period 1950-1960. We focus on the decade of the 1950s as much of our data are for the decadal end points, and the drought began and ended in slightly different years across counties. Specifically, if on average 20 percent of a county's land area was in drought over the 1950s, then this variable would equal 20. IA Table A1.1 reports summary statistics for this measure for the nine standard geographic Census regions.

Panel A of Figure 1 shows that from 1895-1949, drought conditions were very similar among counties that subsequently become affected by the 1950s drought compared to those that were less affected. The solid line in Panel A plots the monthly time series of the mean percent of land area in extreme drought between 1895-1949 for the sample of counties that subsequently became exposed to the 1950s drought (for the 1950s drought, we focus on top quartile exposure, which we will describe shortly), the dashed line is a similar series for the subsample of counties outside the top-quartile of exposure to the 1950s drought. Panel A shows that these two series tended to move together in the 636 months before the onset of the 1950s drought, with the exception of some months during the Dust Bowl period. During this 1895-1949 period, the coefficient from a simple bivariate regression of the mean percent of the land area in extreme drought across counties not subsequently exposed to the 1950s drought on the mean percent in those that eventually had top-quartile exposure to the 1950s drought is 0.95 (p-value<0.00).

Panel B of Figure 1 repeats this exercise for the period 1950-1960. Naturally during this period, the mean percent of the land area in extreme drought among the sample of top quartile drought exposed counties diverges sharply from the non-drought exposed counties.

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[2] The Standardized Precipitation Index (SPI) is a widely used indicator of drought (Guttman 1999). It is a probability-based measure of drought based on the deviation of precipitation over a particular time period from its historical distribution. The SPI is thus comparable across space, and can be measured at different time scales. For example, an SPI that measures precipitation deviations from its historical mean at a 3 month frequency measures soil moisture conditions, while SPI indices based on a longer time scale, such as the 9 month deviation in precipitation from its historical average, captures more chronic drought conditions that impact soil moisture, as well as ground water and reservoir storage.

And the coefficient from the simple monthly bivariate regression drops to 0.21 (p-value<0.00).

Next, Panel C plots these two time series over the 1960-1980 period. The previously non-drought sample is now somewhat more arid than the 1950s drought exposed counties in the early 1960s, but there is substantial co-movement once again. The bivariate regression coefficient is 0.90 during this 1960-1980 period (p-value<0.00). In sum, counties in the sample had very similar drought conditions in the decades before 1950; during the 1950s some counties became exposed to extreme drought conditions; while after the 1950s, the counties in our sample again experienced similar aridity.[3]

This evidence suggests the 1950s drought, despite its prolonged effect, was not a persistent change in weather patterns. By the 1960s, familiar weather patterns returned. While doing nothing may be the appropriate response to a short drought, and migration may be the optimal response to a permanent change in weather conditions (at least for some share of those dependent on agriculture), prima facie, there seems to be a case for people to adapt to a prolonged drought if they can, rather than migrate permanently – this avoids the high initial costs of liquidating property, buying property afresh, and re-establishing organizational capital and social ties ((Carrington, Detragiache et al. 1996)).

The loss in community health for those left behind, as well as adjustment costs for receiving communities, are additional reasons to favor in-place adaptation over migration. Of course, if the local labor market becomes tighter and wages higher when workers emigrate, some segments of the population, for example workers that stay behind, can benefit (see, for example, Jayachandran (2006)). So we cannot claim the absence of emigration universally enhances well-being, only that it is likely to help many.

It is less clear when one would expect a response through adaptation or migration, given the uncertainty about the duration of the change in weather patterns. Migration could be driven by income stress, and could occur early in a drought if farmers and businesses in the local area have

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[3] A simple difference-in-difference (DiD) framework using a county-year panel from the 993 counties in the stratified sample (see later), averaging the monthly data on the percent of land area in extreme drought up to the year-level for each county, formalizes the graphical evidence. In this panel, a treated county is one that experienced top-quartile exposure to the drought in the 1950s (1950-1960). The DiD estimator computes the difference in the mean percent of a county's land in area in extreme drought during the 1950s drought for those counties with top quartile drought exposure compared to those counties outside the top-quartile and relative to other years in the sample. The DiD estimate suggests that the percent of land area in extreme drought is 5.93 (p-value<0.00) percent higher in these top quartile counties during the 1950s relative to otherwise. We get a similar estimate when using the comprehensive sample of over-3000 US counties.

limited resources to make payrolls. Adaptation investment, for instance, in irrigation may occur quickly if this is likely to be beneficial regardless of the drought. But given the irreversibility of these investments, and the possibility that their benefits might be small in non-drought states of the world, adaptation might be delayed until the farmer becomes more certain of a change in weather patterns. We elaborate on these issues below.

1.2. Hypothesis

Adaptation may require a locality's farms, businesses, and individuals to invest in working capital, irrigation, machines, or livelihood support. The greater availability of credit has a number of effects.

Survival and Adaptation

An adverse shock that reduces cash flows and collateral values also reduces an enterprise's borrowing capacity, especially in the presence of financial frictions that prevent the full present value of an investment from being pledged to financiers.[4] At the same time, the adverse shock may itself require more spending by enterprises for their own survival. For instance, farms may need key inputs like new seeds and fertilizers to keep production going. Farmers with little revenues may also need to borrow to pay workers and put food on the table for their own families. Spending that helps farms survive is likely to have high private and social returns, especially if it preserves human and organizational capital. Farm failures were indeed of great importance during the 1950s Drought. Texas lost nearly 100,000 farms and ranches over the 1950s, exceeding losses in the Dust Bowl years.

An adverse shock such as a persistent drought may also increase the return from adaptation investments, for instance from irrigation. Furthermore, to the extent that production has to be curtailed during investment because key inputs to production are unavailable (for example, because farmer labor is devoted to supervising the investment, or land cannot be planted as irrigation pumps are being installed), a time of low productivity may imply a low opportunity cost in terms of lost production and hence greater effective returns to investment (Aghion, Angeletos et al. (2010)).

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[4] See, for example, Bernanke and Gertler (1989), Hart and Moore (1994), or Kiyotaki and Moore (1997).

Land use

Farmers could increase farmed acreage to compensate for lower yields, and to better use fixed investments in irrigation. Access to credit would again facilitate such investment, which would be seen as an increase in aggregate farm acreage. There may also be substitution amongst investments depending on access to credit. For instance, farms may shift to drought-hardy crops if sufficient credit is not available for more capital intensive irrigation investments.

Spillovers

Investment, facilitated by easier access to credit, could also result in sectoral and geographic spillovers. Specifically, the survival and continuing presence of marginal farmers as well as the expansion of large farm production in drought-stricken areas with access to credit could result in more jobs and preserved livelihoods. This could then draw migrants from neighboring drought-hit areas with limited credit access.

Consequences for demographics

Better adaptation and livelihood preservation will also keep able bodied workers and their families from migrating. Because these workers are also the most fertile and healthy age group, birth rates should be higher and death rates lower in counties with greater credit availability in the short term. Overall, as migration stabilizes post drought, areas that adapted more to the drought should have relatively higher population over the longer term as a result of the drought shock.

1.3 Credit Data

Even today, small business bank lending is an intensely local business and agricultural lending more so.[5] Given that communications technology was even less well developed in the 1950s, lending depended on the availability of credit within the town or county in which the farm or business was located. While agricultural production occurs in rural areas, incorporated towns were the predominant centers of finance in most counties during this period. We thus first hand-collected data on the balance sheets of all banks headquartered in a stratified random sample of

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[5] Petersen and Rajan (2002) find that the mean distance between small businesses and their bank lender was 16 miles in the 1970s (median 2 miles), and this had increased with the advent of information technology to 68 miles in the early 1990s (median 5 miles). In 2000, Granja, Leuz, and Rajan (2022) find that the average distance between bank and borrower for all loans is around 200 miles, and the median for all loans is still around 5 miles. The mean distance between borrower and lending branch for agricultural loans is only around 50 miles at this time – so agricultural loans are even more local.

about 1,300 towns across the US in end-1929, 1939, 1950 and 1960—the towns are shown in IA Figure A1.3 for the 1950 snapshot of the panel.[6] Note that the number of banks vary in each period of the panel, so that we have 5,621 banks in 1929; 2,985 banks in 1939; 2,896 banks in 1950 and 3,027 banks in 1960. For each bank, we collected basic information on the value of loans, assets, deposits, capital, and other balance sheet variables. Henceforth, we will refer to these data as the "stratified" sample.

For much of the analysis we aggregate the bank-level data up to the county-level to construct standard measures of credit availability in a county just before the drought. Our first measure of credit availability is the log of loans per capita in a county in 1950. Later, when we focus on agricultural investment, we proxy for credit availability to agriculture with loans per acre of farmed land. A related measure of credit availability, which relates to bank proximity but not bank lending, is the number of banks per square mile. All these proxies should be higher in areas where banks have historically been better able to overcome information, spatial and other frictions in order to establish credit relationships, and thus would have a greater capacity to accommodate a drought-related increase in the demand for bank finance.

Matt Jaremski kindly allowed us to supplement our hand collected data with his data on banks and their locations (henceforth the "comprehensive" sample), which covers the near universe of counties in 1950 and includes the number of banks in a county. Professor Jaremski's dataset is also hand entered, and there is a high correlation between the number of banks in a county in our stratified sample and Professor Jaremski's comprehensive sample —the correlation coefficient is 0.70.[7] However, there is more noise in the bank balance sheet data aggregated up to the county. So for the comprehensive dataset, which covers nearly all counties in the continental US, we focus on banks per square mile as a measure of credit availability.

Table 1 summarizes these standard ex-ante credit availability measures in 1950. At the county level, the mean loans per capita (in the stratified data) is about $115 or about $1,400 in 2022 dollars, and on average, there are about 4 banks per 1000 square miles in the county (in the comprehensive dataset). Towns are geographically much smaller than counties, and these credit availability measures tend to be higher when measured at this more granular level. Because there are a number of small towns in the sample, the variability in loans per capita and the number of

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[6] These data are hand collected from the Polk Banker's Directory in 1929; 1939; 1950 and 1960.

[7] Since we do not sample all towns in a county, there will be some noise in any measure.

banks per square mile also tend to be higher at the town-level. Panel B shows that in the stratified data, the various measures of credit availability are positively correlated. The panel regresses loans, scaled by population (column 1); the number of farms (column 2); and the acreage in agriculture (column 3) on the number of banks per square mile in the county. In all cases the regression semi-elasticities are positive and significant. From column 1, a one standard deviation increase in banks per square mile is associated with a 10 percent increase in loans per capita.

We focus on banks because they were an important source of farm credit during this period, especially for working capital and equipment financing (Herder 1970). [8] IA Table A1.2 shows that banks accounted for about 28 percent of all credit flowing into the farming sector in 1950. Banks specialized in working capital and equipment financing loans, accounting for about 40 percent of such loans. Merchants and dealers, such as captive financiers, provided most of the remaining financing for these non-real estate loans. In the case of real-estate loans, banks supplied only about 16.8 percent of mortgage credit in 1950, with life insurance companies and other institutions doing the bulk of mortgage financing. Thus, the potential supply of bank finance is likely to be more useful for farmers investing in irrigation equipment to adapt to the drought than for land purchases. To the extent, however, that banks monitor on behalf of more passive lenders (e.g., Diamond (1997)), the availability of bank credit should influence all forms of credit.[9]

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[8] See the narrative evidence at https://livinghistoryfarm.org/farminginthe40s/money_12.html. For example “"They just probably knew me," he says. "Knew my dad and so forth... [Now] you put down what you want to do, what your costs for different fertilizer, seed and so forth, irrigation. You go through that every year with the bank … and try to see what the bottom line is going to look like at the end of the year. So, they play a part in the role of most farmers."

[9] The federal government was also a source of agricultural finance during this period as well. The government, through the now defunct Farm Credit Administration, accounted for about 5 percent of the total credit flowing into agricultural economy in 1950. Other government and quasi government agencies, such as the Federal Land Banks, Federal Intermediate Credit Banks, and various production credit associations supplied another 13 percent of credit to the agricultural economy around this time. The federal government also responded to the drought as well, including a drought disaster loan program for businesses administered by the Small Business Association, as well as through the Federal Crop Insurance Corporation (FCIC). But enrollment in this program was voluntary, leaving many farmers without support. Also, the FCIC itself exited some of the most afflicted “Dust Bowl” counties in 1955 (Eisenhower, D.D., 1957. Presidential Message, Alleviating Emergency Conditions Brought About by Prolonged Drought and Other Severe Natural Disasters. 85th Congress, 1st Session. House Doc. No. 110).

1.4. Economic and Demographic Data

Adverse productivity shocks like droughts have non-linear effects on agricultural production and local economic activity. A drought of moderate intensity can make existing capital—livestock and trees—less productive; can diminish milk production or harvests, temporarily reducing cash-flow among farms and local businesses. But a more severe drought can destroy the underlying "physical" capital on the farm—killing livestock and trees and causing soil erosion—leading to an increase in demand for both working capital and investment finance in order for farms to survive, replace physical capital, and make adaptive investments.

Therefore, our main measure of extreme drought in the paper will be an indicator variable that equals 1 if a county is in the top quartile of drought exposure between 1950 and 1960. Because drought exposure measures the percent of a county that is in extreme drought stress averaged over the period 1950-1960 (see earlier), this indicator proxies for how widespread and prolonged stress is in a county. For the town-level analysis, we use the same county-level drought indicator.

The specific timing and intensity of droughts reflect exogenous geophysical forces—in this case a change in the jet stream (Nace and Pluhowski (1965)). But it is possible that ex-ante credit availability, as well as key economic and demographic factors might differ systemically between drought-affected counties and the other counties in the sample. Notably, the drought was particularly severe in some of the big Sunbelt states like Georgia, Texas and Oklahoma. And in 1950, these states were relatively less populated, as the post-war demographic shift towards the Sunbelt states was still nascent. Indeed, among counties with top quartile drought exposure, the mean of the log population in 1950 was 10.12, while the mean for counties outside the top-quartile was 10.58—a mean difference that is economically small but statistically significant at the 1 percent level. In all our specifications we control for the log population in 1950 and the county's land area.

Table 2 considers a comprehensive series of "balance tests", regressing a range of the most salient potential ex-ante confounders, all observed circa 1950 on the top-quartile drought indicator variable based on drought conditions between 1950 and 1960. These tests check whether counties that subsequently became exposed to the drought were ex-ante different than the other counties in the sample. Panel A of Table 2 includes only state-fixed effects, while Panel B also controls for the log of a county's population in 1950; Panel C of Table 2 drops the state-fixed effects.

Table 2 show that the ex-ante structure of the local banking system; median income; the structure and productivity of agriculture; and the broader local economy were all ex-ante similar between top-quartile drought exposed counties and the other counties in the sample. Specifically, loans per capita, the number of banks per square mile, and the value of deposits per capita, all observed in 1950, were indistinguishable across the two samples. Likewise, the capacity for ex-ante self-insurance, as proxied for by the log of median income in 1950; along with the mean farm size; the number of farms; the productivity of farmland and the share of irrigated farmland were all similar between top-quartile drought exposed counties and the other counties. This pattern holds when we include state fixed effects (Panel A); control for a county's population in 1950 (Panel B); and exclude state fixed effects (Panel C). Table IA A1.3 repeats this exercise for the comprehensive sample. Across the 3000 or so counties in this sample, the ex-ante variables, including banks per square mile, are uncorrelated with subsequent drought exposure.

That top quartile drought exposed counties and the other counties in the sample are similar on a range of pre-drought dimensions is consistent with the fact that the 1950s drought emerged from geophysical forces that did not "select" on ex-ante local economic and demographic factors. It also echoes the evidence in Figure 1 which shows that apart from the 1950s, both sets of counties experience similar aridity patterns. Taken together, this evidence implies that any pre-existing differences between counties that eventually had top-quartile exposure to the 1950s drought and other counties in the sample are likely to be slight.

2. Basic results on drought exposure and the impact of credit

We first establish the correlations between drought and population, and the mediating effect of credit. We will turn in the next section to evidence of the causal effect of the availability of credit on credit growth and demographic outcomes.

2.1 County-Level Evidence

We present the demographic impact of the drought using a county-level panel of population from 1930 through 1980. The 1950s drought was an unexpectedly prolonged adverse shock, but it occurred against a backdrop of substantial post-war change. A longer term panel analysis allows us to absorb potentially important confounding factors like the era's rapid technological change or secular trends in urbanization. The baseline panel thus includes state-by-decade fixed effects to help absorb these time-varying trends. A longer term panel also helps us illustrate both pre and post drought dynamics.

Figure 2 charts population trends using the stratified county-level panel and an event study analysis. The figure is normalized so that the base year is 1950. The event study allows the impact of top quartile drought exposure on population to vary by decade and shows that before 1940, population trends were similar among counties that subsequently became exposed to the drought and those that did not. But these population trends diverged from 1950, as the drought set in (around 1947 in the earliest hit areas). The population in 1960 is about 4.5 percent lower in drought exposed counties relative to the 1950 base year. This effect doubles to around 9.4 percent in 1970. Population losses then slow during the 1970s, so that the population in 1980 is about 11.7 percent lower on average among drought exposed counties compared to if these counties were not otherwise exposed to the drought.

Following the event-study plot, Table 3 uses a difference-in-difference (DD) research design to study the demographic impact of the drought. We construct a term "Post 1950s * drought exposure" which is the interaction between an indicator for the decades after the 1950s and an indicator for whether the county was in the top quartile of drought exposure in the 1950s.

The coefficient estimate on the interaction term in column 1 for "Post 1950s * drought exposure" measures the difference in population in the decades after a county suffers top quartile drought exposure in the 1950s relative to the decades before, as well as compared to the population dynamics in counties that were never in the top quartile of the drought exposure distribution.[10] The estimate mirrors the event-study graph in Figure 2, suggesting that counties with top-quartile drought exposure experienced a 10.8 percent decline in population (p-value<0.001) in the decades 1960-1980 relative to if they were not otherwise exposed to the drought.

We now examine the role of ex-ante credit access in mediating the demographic impact of the drought. Before turning to the parametric evidence, the event study plot in Figure 3 allows the impact of the drought on population to vary depending on whether the county is in the bottom

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[10] Note that because the 1950s drought was a single event when observed at the decadal frequency, all counties were either potentially exposed (treated) or not exposed to the drought at the same time. Thus, unlike more complex settings in which treatment occurs at different times for different units, our setting can more easily identify the average treatment effect of the drought on drought-exposed counties (Goodman-Bacon 2021, Sun and Abraham 2021).

quartile of loans per capita in 1950 or the top quartile. The adverse impact of the drought on population was larger among counties in the bottom quartile of loans per capita. Among counties above the 75th percentile of loans per capita, drought exposure is associated with a 5.6 percentage point decline in population by 1980 (p-value=0.12). But for those counties in the bottom quartile, population is about 18.2 percent lower relative to if these counties did not experience a drought (p-value<0.01).

To examine the importance of credit availability, in Table 3, column 2 we interact loans per capita in 1950 with the "post-1950 indicator *drought exposure" term along with all subcomponents, using the stratified sample. The specification also interacts "post-1950 indicator *drought exposure" with a county's land area to absorb any mechanical county size effects. It may also be that rather than measuring the capacity of the local banking system to lend into the drought, loans per capita in a county proxies for the local population's self-insurance capacity; in counties with higher levels of income or bank deposits, the local population can more easily rely on their savings in order to adapt to the drought and remain within the county. Column 2 thus allows the impact of drought exposure to also depend on the mean income in the county and on bank deposits per capita. Consistent with the event study evidence in Figure 3, the loans per capita term is still significant (p-value=0.07) and economically large. Moving from the 25th to the 75th percentile of loans per capita is associated with a lower negative impact of drought exposure on population by about 5.5 percentage points on average in the post-drought decades. As a further check, column 3 includes county and year fixed effects to absorb respectively county-level time invariant factors and national-level trends. The point estimate on the loans per capita interaction is somewhat larger in magnitude and statistically significant (p-value=0.02).[11]

Recall the measure of credit availability we have in the comprehensive sample is the 1950s number of banks per square mile in the county. Column 4 shows that including banks per square mile instead of loans per capita in the stratified sample produces similar results. We then re-estimate the model using the comprehensive sample (column 5). The point estimate on the interaction between post 1950s drought exposure and banks per square mile is somewhat smaller

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[11] In IA Table A1.4, we zoom in on the 1950-1960 cross-section to consider a series of additional robustness checks. These checks show for example that the impact of drought exposure on population is similar for the subsample of counties for which we have credit data, as well as the population of counties; these tests consider alternative measures of drought exposure, such as the continuous mean percent of land area in extreme drought; and other possible channels, including economic diversification.

but remains statistically significant (p-value=0.04). Moving from the 25th to the 75th percentile of the number of banks per square mile in a county in 1950 is associated with a lower negative impact of drought exposure on population by about 3.3 percentage points on average in the decades that followed. So both the stratified sample and the comprehensive sample offer similar baseline effects, though the data and the measures of credit availability differ.

3. Identification

The evidence thus far is consistent with credit availability being associated with less population decline (and thus, indirectly, suggestive of greater adaptation), but as Table IA A1.5 shows, there are other plausible alternative interpretations. Loans per capita is positively correlated with deposits per capita and median income and other potentially important variables. We have of course controlled for these possible confounders both in the cross-section and panel contexts, but we now conduct tests that suggest greater evidence of the causal effects of credit availability.

First, we isolate regulatory differences that caused different credit availability in drought-affected areas under the regulation than in drought-affected areas not under the regulation. This helps identification. Second, we examine the specific mechanism through which credit availability affects adaptation: through investment in irrigation. If differences in credit availability driven by regulation affect differences in adaptation investment, we have much stronger evidence of causality.

3.1. Branching regulations and credit availability

In the 1950s, branching regulations varied across states. In our stratified sample, 8 states were unit banking states (Figure 4), where a bank could have only one office and could not open additional branches.[12] Four states had no specific laws on branching, while 15 states allowed full branching, so that banks were free to open up branches anywhere within the state; the remaining branching states limited branching to either within the same town or county in which the bank

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[12] The 8 unit banking states are: Colorado; Florida; Illinois; Minnesota; Montana; Nebraska; Texas and West Virginia.

was headquartered.[13] In what follows, we label both full branching and limited branching states as branching states—we exclude the 4 states with no legislation regarding branch banking.

Standard risk-sharing-through-geographic-diversification arguments predict that in drought exposed areas, banks in branching states would be better able to meet loan demand relative to unit banks. On the asset side of the balance sheet, banks in branching states would be less exposed to large losses stemming from concentrated lending in drought exposed areas, preserving their lending capacity relative to unit banks. On the liabilities side of the balance sheet, branching networks can also raise deposits or transfer spare liquidity more easily from non-drought exposed parts of the state to make loans in the drought affected areas. This movement of funds within the bank branch network to meet the liquidity needs of the local drought exposed population also limits inefficient loan sales and local fire-sales.

In contrast, unit banks would suffer greater loan and capital losses because of direct exposure to the drought, and have to rely on risk-sharing through their less-reliable correspondent banking relationships, making them less able to lend after the drought hit compared to banks that have a branch network. Consistent with the lack of diversification in unit banking, a number of papers suggest there was more banking distress among unit banks during the Depression than in banks in branch banking states (see, for example, Calomiris (2000), Michener (2005), Wheelock (1995)).[14]

There are, of course, reasons why a unit bank, if it stays healthy, might lend more locally after a shock, such as its inability to lend outside the distressed area, unlike a branch bank.[15] So whether unit banks lend more locally after a shock or less depends on their health conditional on the shock. Comprehensive shocks like the drought, we hypothesize, would more likely impair existing unit bank loans, capital, and also their deposit base, thus hampering new lending relative to that of branch banks.

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[13] The distribution is similar in the comprehensive sample: 9 states prohibited branching; 18 states allowed state wide branching and 5 states had no branching laws. The remaining 17 states permitted some form of branching either in the city or county in which the bank was headquartered.

[14] Unit banks have especially struggled in agricultural areas. Writing after the twin banking and agricultural crises of the 1920s, Cartinhour (1931) observes: "The appalling mortality record of the small unit banks located in purely agricultural territory has been revealed elsewhere. In the main the wholesale colossal number of small bank failures can probably be charged to the unit system itself. The banks have limited capital, little or no credit with correspondent banks, with no affiliated bank to lean upon and with no diversity loans—when there occurs a shortage or failure of crops…"

[15] Conversely, banks might be more discriminating in their use of funds in branching states, rebalancing lending away from risky drought exposed areas towards less drought exposed parts of the state (Commission (1935)).

In what follows, we find unit banks lend less into the drought, controlling for other factors. The unit of observation in Table 4 is at the bank-level, and we use the set of banks with data in both 1950 and 1960. The dependent variable is the change in a bank's loans between 1950 and 1960, scaled by the bank's assets in 1950. The analysis begins with all available banks in the sample, regardless of their distance from a branching or unit banking border. This results in 1,730 banks with complete balance sheet and county-level data both in 1950 and 1960. The specification uses an indicator variable that equals 1 if a bank is located in a branching state, and 0 if the bank is in a unit banking state. We interact this branching variable with the top quartile drought indicator variable, including the drought indicator directly as well. The analysis also includes a bank's capital to asset ratio; loans and discounts to assets ratio; deposit to asset ratio, and log assets, all observed in 1950, along with state fixed effects; standard errors are clustered at the state level.

From Table 4 column 1, drought exposure is associated with an average 7.95 percent point decline in lending among banks in unit banking states (p-value<0.01), while the coefficient on the branching-drought exposure interaction term is positive and significant (p-value=0.04). The difference in the average drought loan response between branching and unit banking states is given by the coefficient estimate on the drought exposure*branching interaction minus the coefficient on the direct effect of the drought, and this difference is 14.7 percentage points (p-value=0.01).

A bank's liquidity, equity, and size can all influence its lending during periods of distress. In column 2, we interact drought exposure with these key bank-level balance sheet characteristics to help exclude alternative interpretations, and understand better the mechanism through which branching might shape the loan response. Since drought exposure enters in a number of additional ways in columns 2-5, the key coefficient estimate of interest should be the interaction of drought exposure with the branching indicator. In column 2, it is similar in magnitude to that in column 1, with the coefficient estimate on the interaction term between drought exposure and branching positive and significant at the 1 percent level.

Column 2 also suggests that while the direct effect of making more loans in 1950 is positively associated with greater subsequent lending, drought-affected banks with higher ratios of loans to assets in 1950 lent relatively less in response to the drought, consistent with their making greater losses on existing loans, which would impact capital and lending ability. Of course, on net, the former effect is of higher magnitude, so banks making more loans in 1950 also lent more in the drought. Column 3 allows the marginal impact of the drought on lending to depend also on county-level observables like income; mean farm size; log population; and the rural share of the population to further absorb unobserved heterogeneity. Loan growth remains elevated in drought exposed banks in branching states relative to their unit-banking counterparts.

The bank-level evidence thus far suggests that risk diversification through branching mediated the loan response to the drought. But as Table IA A1.6 shows, there are mostly economically small but statistically significant differences between banks, and even counties, in branching versus unit banking states. For example, the mean loans to asset ratio in 1950 at banks in branching states is about 4 percentage points higher than in unit banking states (p-value<0.01). Likewise mean farm sizes in unit-banking counties exceed those in branching counties (p-value<0.01).[16] Clearly then, because of their differing economic and political histories, branching and unit banking states differed in 1950 on a number of dimensions, and these differences, even at the bank-level, could contaminate inference about relative loan growth. Because this will be an important input to our subsequent analysis, we go further here to correct for other spurious differences.

We restrict the baseline analysis to banks located in counties with a centroid no further than 200 miles from a branching-unit banking state border. To identify these borders, we begin with the 8 unit banking states for which we have bank-level data, along with the states that had laws explicitly allowing some kind of branching—we initially omit the 4 states that had no explicit regulations on the spatial provision of banking services—see Figure 4. As before, we use an indicator variable equal to 1 if a bank is located on the branching side of a state border, and 0 if the bank is on the unit bank side. We interact this branching variable with the top quartile drought indicator variable, including the drought indicator directly as well. Following (Holmes 1998), all specifications linearly include a county's distance from the particular state border—there is little variation in this variable as it is bounded at 200 miles—and use a third order polynomial to control for a county's distance along a particular state border.

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[16] At the same time, studies find that, if anything, branch banking states were underbanked relative to unit banking states in terms of access to banking offices over the period of our study (see Horvitz and Shull (1964), Jacobs (1965), Pakonen (1969)).

Panel B of Figure 4 helps to visualize the research design using the Georgia-Florida state border as an example. Georgia (GA) was a branching state, while Florida (FL) only allowed unit banking. This state-level difference in branching regulation between these two adjacent states makes the GA-FL state border a branching-unit banking border. This border is approximately 260 miles long when measured from east to west. The research design only includes counties along this 260 mile border that have a minimum distance centroid no further than 200 miles either north (in GA) or south (in FL) from the GA-FL state border itself. This means that all counties in our GA-FL sample have a minimum distance of no more than 200 miles from the border, while each county's distance along the border, measured from west to east, varies from 0 to 260 miles.

If we restrict the sample to counties no further than 200 miles from a branching-unit banking state border, we get 530 counties and 1,166 banks. The balance tests in IA Table A1.6 (panels C and D) show that these geographically proximate counties are much more similar, as even mean farm sizes are now statistically indistinguishable across the two sets of counties (p-value=0.36). At the bank-level, differences have also narrowed considerably, though in 1950 there is evidence that banks in branching states, with their easier ability to rearrange liquidity across their branching network, generally had higher loans to asset ratios than unit banks. In this smaller sample of banks, column 4 of Table 4 continues to suggest that branching mediated the loan response to the drought. The relative difference in the average drought loan response between branching and unit banking states in column 4 is virtually unchanged from column 3 and is about 6.1 percentage points (p-value=0.05). Column 4 restricts the sample to counties along state borders between unit banking states and those states that explicitly allowed branching, omitting the 4 states in our sample that had no laws on branching. As a robustness exercise, column 5 repeats this border exercise, but also includes state borders between unit banking states and those that had no explicit branching laws (classifying these as branching states). The results are little changed.

The evidence suggests that loan growth was significantly higher for banks headquartered in drought-affected counties in branching states than for similar banks in unit banking states. This offers us a means of identification -- the indicator for unit banking should attenuate the impact of any ex ante indicator of credit availability such as loans per capita or number of banks per capita, conditional on the drought. For a given ex-ante degree of credit availability, branching banks might suffer less from losses due to concentrated exposure to the drought, and have greater access to spare liquidity through their branching network to lend into the drought. In contrast, higher levels of ex-ante credit in unit banking states might be more ambiguous. Unit banks that lent extensively before the drought might now suffer greater loan impairments in drought exposed areas, eroding their capacity to lend into drought. All this suggests that these regulatory differences can exogenously mediate the effects of ex-ante credit conditional on the drought.

3.2 Adaptation through irrigation

The availability of credit should influence irrigation investment, widely perceived to be the "premier" adaptation margin to drought (Saarinen (1966)). And during our sample period, the center-pivot system was the breakthrough innovation that allowed farmers to access groundwater. For example, irrigated acreage in Kansas grew from 250,000 acres in 1940 to about 1,000,000 acres by 1959 largely on account of the adoption of these center-pivot systems. This adaptation margin entails both significant upfront capital investments—reliable gasoline and diesel engines as well as drilling, using technologies adapted from the oil-industry—and higher operating expenses including fuel and ongoing maintenance costs. Access to finance is thus widely believed to have shaped this adaptation margin (Wiener, Pulwarty et al. (2016)).

In order to measure the importance of ex-ante credit in enabling the shift to irrigated farming in drought areas, we use relatively high-frequency data on well-depths taken from approximately 106,000 wells. The idea is that there is increased aquifer depletion in drought exposed areas when credit is used to finance a shift to ground-water irrigation. This will increase the depth of wells in the county—the distance from the surface to the water-level in the well. However, in drought exposed areas with aquifers but limited access to finance, the inability to finance adaptation investment coupled with the overall decline in agriculture will create less aquifer discharge, resulting in shallower well-depths.

The United States Geological Survey began collecting data on the water depth of these 106,000 wells in 1950.[17] On average each of these wells was sampled every 80 days during our 1950-1970 sample period. Over the period 1950-1970, the summary statistics in IA Table A1.7 show that the mean well depth over the sample period was 64.1 feet with a standard deviation of

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[17] The data are obtained from https://waterservices.usgs.gov/rest/GW-Levels-Service.html. An overview of water monitoring and well-depth observations in the United States can be found here: https://cida.usgs.gov/ngwmn/doc/ngwmn_framework_report_july2013.pdf

89.5 feet. Wells in drought exposed counties during the drought period (1950-1957) were about 4 feet deeper than wells not exposed to drought conditions (p-value<0.00).

The US government did not observe well-depths before 1950 and we cannot formally test for differences in pre-drought trends across these counties. But the event study analysis in Figure 5 illustrates the well-depth dynamics across these counties and helps to connect causally the timing of drought exposure, credit and the shift towards ground-water irrigation. The data are observed at the well-observation date level and constitute an unbalanced panel over the sample period 1950-1970 that produce about 740,178 well-depth observations in our stratified sample—wells in counties with credit data.

This well-level panel structure allow us to include county fixed effects (because whether a county is in drought varies over time), absorbing local geographic and other time-invariant factors, such as the size of underlying aquifer. Also, because we are focused on agricultural investment, the more appropriate measures of credit availability for the stratified data are loans per acre of farmed land or loans per farm —both are highly positively correlated with each other and with loans per capita (Table 1). In what follows, for brevity we present only the loans per acre results, but obtain similar results with loans per farm. For the comprehensive sample, we use banks per square mile.

For each year of drought, the event-study figure plots the average difference in well depth in counties at the 90th percentile of loans per acre to those at the 10th percentile (Figure 5). This average difference is allowed to vary by year from 1950 through 1965—the first seven years of the drought in the sample period—1950-1957—and the seven years immediately after the drought ends—1958-1965. Using loans per acre as the measure of ex-ante credit access in our stratified sample, well depth is on average about 45 feet deeper from 1950 to 1956—the peak drought years—in wells located in counties at the 90th percentile of bank finance relative to those at the 10th percentile. But once the drought ends circa 1957 and the rains recharge the aquifers, this gap shrinks rapidly to around zero, becoming insignificant by 1958.

The timing in the event study analysis points to credit as a key factor in the irrigation response to the drought. Panel B, which restricts the analysis to unit banking states is equally illuminating. It suggests that in unit banking states, wells in areas with more ex ante credit availability had, if anything, shallower wells in the early years of the drought, though the difference is barely statistically significant. This is suggestive of banks with more ex ante loan exposure being more impaired in those states. Eventually, the difference in well depths hugs zero and is never statistically significantly different from it. The bottom line is there is very little difference in well depth between areas with high ex ante credit availability and the areas with low ex ante credit availability in unit banking states, suggestive of a uniform lack of availability of credit.

The estimates are very different in branch banking states, as can be seen in Figure 5 panel C, where well depths are significantly higher in areas with high credit availability. Figure 6 repeats this exercise using banks per square mile for the comprehensive sample. This yields just under 1.8 million well-depth observations. In this larger sample, the estimates continue to show significant differences in well depths between areas with banks per square mile at the 90th and 10th percentiles during the drought years; and about a year or two after the drought ended in many counties and aquifers recharged, well-depth differences between these areas vanish.

In Figure 6 Panel A-C, we repeat the analysis using the comprehensive sample and ex-ante credit availability, measured in this case using banks per square mile. We find similar results to those in Figure 5 Panel A-C: ex ante credit availability has no effect on subsequent well-depth differences in unit banking states, but is associated with significant differences in well depths only during the drought years among branching states.

We then turn to regression analysis. Column 1 of Table 5 examines the average impact of drought exposure and bank credit access on well depth using a difference-in-difference design. The specification includes an indicator variable that equals 1 if a well is located in a county-year pair that is in drought and 0 otherwise. We interact the county-year drought indicator variable with the 1950 loans per acre. This interaction term measures whether the average effect of drought exposure on well depth varies with credit availability in the county. The sample period remains 1950-1970 and consists of all states with available data.

From column 1, the coefficient on the interaction term between the time-varying drought exposure variable and loans per acre in 1950 is positive and significant—well depths are deeper in drought exposed counties with more ex-ante credit access. For a county at the 10th percentile of loans per acre, top quartile drought exposure implies a -11.98 feet decrease in the average well-depth in the county, as agriculture declined along with water usage. But for a county at the 90th percentile of loans per acre well depth increases by 23.4 feet—a difference of about 34 feet from well depths for counties at the 10th percentile; this difference is significant at higher than the 1 percent level.

To identify better the role of credit in shaping the irrigation response, column 2 of Table 5 relies on the previous bank-level result showing that unit banks were less able to increase credit in response to the drought. The basic rationale behind this test is that because unit banks were less able to offer credit, loans per acre should matter less for shaping well-depth among drought affected counties in unit banking states. In column 2 we estimate a triple interaction term. The specification allows the marginal impact of drought exposure to depend both on loans per acre, and an indicator variable for whether the county is in a unit-banking state—all lower order terms are included. The coefficient estimate of the triple interaction is negative and highly statistically significant, suggesting well depths are shallower in unit banking states in areas of high credit availability.

We then calculate the full marginal effects in unit banking states at different levels of credit availability. Specifically, at the 10th percentile of ex ante credit availability, well depth is shallower in both drought-affected counties in unit banking states (-0.81 feet, p-value=0.5) and branch banking states (-8.72 feet, p-value=0.1) suggesting little financing. But at the 90th percentile of loans per acre, wells are about 28.8 feet deeper (p-value<0.01) in drought-affected counties in branching states suggesting plentiful financing for irrigation investment. In unit-banking states, however, well-depths are even shallower (-21.96 feet, p-value=0.04), suggesting little incremental financing for irrigation investment, leading farmers to idle production or adjust through less capital intensive margins, such as by planting less thirsty crops. So even in areas with high ex ante proxies for credit availability, farmers in unit banking states do not appear able to increase well depths, adding support to the view that credit supply was essential for adaptation.

In columns (3) and (4), we replicate the results in columns (1) and (2), using banks per square mile as the measure of credit availability, and banking data from the comprehensive sample. We again find that ex-ante credit availability positively affected well-depth during the drought years, especially in branching states. Because unit banking states might differ from branching states on unobserved salient dimensions, column 5 uses our previously described border test, restricting the sample to counties no further than 200 miles from a unit banking-branching border. Column 5 continues to suggest that ex-ante credit availability had a more muted impact on drought adaptation in unit banking states.

While changes in well depth capture the full use of irrigation facilities, including financing the expense of running pumps and sprinklers more intensively, as well as the capital costs for new wells, the number of wells in a county over time allows us to get at the extensive margin alone. In the Internet Appendix Table IA A1.8, the dependent variable is the log number of wells located in a county in each year, and the data are an annual county-level panel from 1950 and 1970. The evidence suggests that ex-ante credit availability shaped adaptation to the drought through irrigation at the extensive margin. The coefficient estimates in column 1 suggest that at the 90th percentile of loans per acre for example, the number of wells increased by about 35.9 percent (p-value<0.01) in drought exposed counties. At the 10th percentile of loans per acre, drought exposure is not significantly associated with an increase in the number of wells.

As we have seen though, the effect of ex-ante credit availability is much more ambiguous in a unit banking state, which is what we see next. Column 2 includes in addition the interaction of drought exposure with unit banking as well the triple interaction term with loans per acre (for brevity we do not report other cross terms). The estimates indicate that at the 10th percentile of the ex-ante loans per acre distribution, the number of wells in drought exposed unit banking counties is about 34.2 percent (p-value=0.01) smaller; in branching counties at the 10th percentile of ex-ante credit, the marginal impact of the drought on the number of wells is not significant. At the 90th percentile of the credit distribution however, drought exposure implies a 42.2 percent (p-value<0.01) increase in the number of wells in branching counties, while the marginal effect of the drought is insignificant in unit banking counties even with loans per acre at the 90th percentile of the distribution. A similar pattern emerges when we measure ex-ante credit using banks per square mile in the comprehensive sample (columns 3 and 4), as well as when we use the sample of counties located within 200 miles of a unit-branching state border (column 5).

4. Adaptation and outcomes

We have established that access to credit influences adaptation through more and deeper irrigation wells, especially in areas with branch banking. We will see this affects the growth in area irrigated. Also, adaptation can occur along less capital intensive dimensions, such as switching to less water intensive crops, especially in areas where bank lending is more constrained. We will see some evidence of that. Finally, we will examine how adaptation affected population dynamics.

4.1. Acreage and other forms of adaptation

The expansion of irrigation through more and deeper wells in response to the drought can allow farmers to expand the overall acreage under irrigation, which would also be a natural response so as to amortize the fixed investment in irrigation. The dependent variable in Panel A of Table 6 is the log difference in irrigated acreage in a county between 1949 and 1959 using the comprehensive sample—banks per square mile in 1950 is the measure of ex-ante credit availability. The coefficient estimate on the triple interaction is negative and significant (p-value=0.07). It suggests that in drought exposed counties at the 90th percentile of the banks per square mile distribution, the growth in irrigated acreage among drought exposed counties was about 76 percentage points less in unit banking counties than in drought exposed branching counties.[18]

Areas with little access to finance might adapt through means that are less capital intensive than irrigation. One such way was to shift to growing drought resistant crops like sorghum, which is often used to feed livestock instead of less-drought tolerant corn during times of drought (Abdel-Ghany, Ullah et al. 2020). Consistent with crop choice as an important adaptation margin, sorghum production significantly expanded across the US during the drought affected 1950s, rising from 12 to 27 million planted acres between 1952 and 1957 (Lin and Hoffman 1990).

If sorghum plantation was more likely in areas that had less access to credit, and therefore greater incentive to shift, the coefficient estimate of interaction term between drought exposure and credit availability should be negative, and the triple interaction including unit banks should be positive. This is indeed what we see in column 2, where the dependent variable is the log change in sorghum acreage in a county using the comprehensive sample. We see that drought exposure is associated with a smaller shift to sorghum in branching counties with plentiful ex ante credit, as farmers in these counties likely adjusted to the drought through more capital intensive irrigation projects. But the coefficient estimate on the triple interaction suggests a greater shift to sorghum in unit banking counties with higher ex ante credit, indicating a relative scarcity of credit.

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[18] Note that this was a period when irrigated agriculture expanded rapidly from a low base in many counties, as the median county saw 2.4 times increase in irrigated acreage between 1949 and 1959.

Finally, we examine whether adaptation can lead to greater growth in output per farm in subsequent years – in part because farms are less debilitated by the drought experience. The dependent variable in column 3 is the log change in output per farm between 1959 and 1969. The estimate on the triple interaction is negative and significant (p-value=0.02), suggesting that ex-ante credit availability was less effective in mitigating the effects of the drought on farm output in unit banking counties. At the 90th percentile of the credit distribution for example, output growth per farm is about 0.09 percentage points smaller in drought exposed unit banking counties relative to those in branching counties. All this suggests that it was easier to adapt and preserve livelihoods in areas with greater access to credit. This must affect population dynamics, which is what we turn to next.

4.2. Population dynamics

By preserving livelihoods, areas with greater access to credit should attract more immigrants from other counties. In Table 6 Panel B, the dependent variable is the percentage of migrants in a county in 1960 from outside that county. The coefficient on the triple interaction is negative and significant, suggesting fewer immigrants in counties with lower access to credit. At the 90th percentile of the credit distribution for example, the percent of migrants in a county is about 2.2 percentage points smaller in drought exposed unit banking counties relative to those in branching counties (p-value=0.07).

The most likely emigrants from economically distressed drought areas would be young workers who can relocate easily. But these are likely to be the most fertile segment of the population, and we would thus expect a fall in birth rates in counties with lower access to credit and less capacity for adaptation investment. This is indeed what we see in column 2, where the dependent variable is the births per capita in 1960. The negative and significant coefficient on the triple interaction suggests a lower birth rate in counties with lower access to credit. At the 90th percentile of the credit distribution for example, the birth rate in a county is about 1.9 percentage points smaller in drought exposed unit banking counties relative to those in branching counties (p-value=0.19). As the young emigrate from drought exposed areas, the remaining population in these areas with lower access to credit are likely to be a selected sample of older and less mobile individuals. In column 3, the dependent variable is the deaths per capita in 1960. At the 90th percentile of the credit distribution, the death rate in a county is about 4.5 percentage points higher in drought exposed unit banking counties relative to those in branching counties (p-value=0.06).

4.3. Long term effects on population

This evidence collectively implies that greater access to credit in drought exposed areas, by enabling adaptation, should support population growth over the longer run. Table 6 Panel C, Column 1 revisits the earlier county-level panel in order to evaluate this implication. The dependent variable is the log of population in a county between 1930 and 1980. The indicator for 4th quarter drought exposure turns on in drought exposed counties from 1960 onwards. The specification also uses the triple interaction term between drought exposure, ex-ante credit availability and the unit banking indictor variable. The coefficient estimate on the triple interaction is negative and significant, suggesting that counties with lower access to credit had significantly lower populations in the decades after the drought. This offers a more causal interpretation to the correlations we presented earlier in the paper.

5. Spillovers

We have argued that credit is extremely local. So the local bank often has proprietary credit information about a borrower that makes it hard for the borrower to reestablish a credit relationship elsewhere. Yet if there is greater availability of credit in a nearby town, and the local bank is linked to banks in nearby towns through correspondent banks or through the local bank's branching network, we would expect more migration towards that nearby town since the credit information will be portable in the network. Put differently, the nearby availability of credit can have spillover effects. Of course, in testing this, we have a standard problem – maybe our measures for availability of credit "work" because they proxy for stronger economic activity.

This is where regulations again help us isolate effects. We have already stated that until the deregulatory waves of the 1980s, interstate branching was prohibited. To the extent that a migrating borrower had to stay near their bank's network of branches—in those states that allowed bank branches--in order to avail of the bank's knowledge about them and obtain additional credit, this would limit credit-induced migratory options to within state.

Moreover, farmers would have existing debt and mortgages, which would need to be evaluated and, sometimes, resolved. Until the enactment of the Uniform Commercial Code in most states starting in the late 1950s (see Braucher (1958)), collateral registration and foreclosure laws and practices differed across states making it difficult for an out-of-state lender to establish the priority of their claim, as well as to seize collateral. Nearby in-state lenders with lawyers admitted to the state bar could more easily assess claims and imminent distress, as well as handle the borrower's past loans and collateral pledges, including livestock and other farm assets, even while lending against new assets. This would be true even in unit banking states. So we would expect that if better credit prospects elsewhere drives outmigration, nearby in-state locations with strong credit availability would be particularly attractive if credit were an important factor, while equidistant out-of-state locations with strong credit availability would not. A potential weakness of this approach though is that we cannot exclude the possibility that social, cultural and other constraints might limit migration patterns across state borders relative to in-state migration.

Towns were the predominant centers of finance in most counties during this period, and we turn to the more granular stratified sample to implement the border tests. The dependent variable in Table 7 is the decadal population of the town from 1930 to 1980. For each town in the sample we locate all towns within a 200 mile radius and in the same state, and then compute the mean per capita credit among these nearby towns in 1950, excluding credit in the reference town itself. Similarly, we locate all towns within the same radius of the reference town, but across the state border and compute the mean per capita credit among that subsample of towns. The baseline estimation includes these two additional variables linearly, as well as interacted with the top quartile drought exposure indicator variable of the town in question.

To exclude mechanical size effects in these border tests, we also compute separately the total population of the towns in the 200 mile radius, in-state and out-of-state, and interact these variables with the drought indicator as well. These specifications all include third order polynomials measuring separately the average distance between a reference town and its in-state neighbors, and the average distance between a reference town and its out-of-state neighbors. Also, these specifications all include an interaction of the town's area with drought exposure as well.[19] The point estimate in column 1 of Table 7 Panel A suggests that a town's population is about 14.4 percent lower than otherwise in the decades after top-quartile drought exposure.

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[19] IA Table A1.9 shows that along several important dimensions, such as median income, loans per capita, deposits per capita, etc., counties located within 200 miles of a state border are similar.

Using this difference-in-difference (DD) design, column 2 of Table 7 allows the impact of the post-1950 drought exposure to depend on the log of loans per capita in the town in 1950. The estimates suggest that loans per capita within the town has an economically large effect on the demographic effects of the drought. For a town at the 25th percentile of loans per capita, drought exposure suggests a 26.5 percentage point decline in population after 1950. But for a town at the 75th percentile of the loans per capita distribution, the decline in population is 12.6 percentage points—this difference of 13.9 percentage points in the impact of the drought over the interquartile range of loans per capita is significant at the one percent level.

Column 3 includes the border test. The specification allows the impact of drought exposure to depend on loans per capita among in-state towns no further than 200 miles from the reference town. It also allows the impact of long-term drought exposure to depend on loans per capita among equidistant out-of-state towns. As noted earlier, the border specifications also allow the impact of drought exposure to depend separately on the overall population among in-state towns within the 200 mile radius, and all specifications include third order polynomials measuring separately the average distance between a reference town and its in-state neighbors, and the average distance between a reference town and its out-of-state neighbors.

As before, the negative impact of drought exposure is smaller when in-town credit availability is high. That is, moving from the 25th to the 75th percentile of in-town loans per capita implies a 15.6 percentage point smaller decline in population in the years after top quartile drought exposure (p-value<0.00). However, consistent with the credit-induced migration hypothesis, the negative impact of drought exposure on a town's population is larger when there are nearby in-state competing sources of finance. A one standard deviation increase in in-state loans per capita suggests a 6.3 percentage point larger decline in a town's population in the decades after top quartile drought exposure (p-value=0.03).

Moreover, the coefficient on loans per capita among equidistant out-of-state towns is positive, small, and not statistically different from zero. Also, the difference between the in-state loans per capita and out-of-state loans per capita coefficients is not only economically large, at 0.187, but statistically significant (p-value=0.03). In column 4 of Table 7 Panel A, we include county instead of state fixed effects. The results are qualitatively similar, though less precisely estimated. Together, the border results suggests that while access to credit within a town reduces the adverse demographic effects of the drought, nearby in-state centers of credit can incentivize outmigration, helping to amplify the adverse demographic effects of the drought on a given town. Equidistant out-of-state sources of finance do not appear to mediate the impact of the drought.

All this suggests that the relative size of a town's banking system can determine the demographic impact of drought exposure. In particular, nearby in-state centers of bank finance are likely to attract migrants when credit availability in these towns is large relative to the size of lending capacity in the drought-affected town itself.

To measure the relative size of a town's banking system, column 5 computes the ratio of loans per capita in town to loans per capita among in-state towns up to 200 miles away; the specification also includes a similar ratio computed for nearby out-of-state towns. A one standard deviation increase in the ratio of town's per capita loans relative to its in-state neighbors reduces the adverse impact of the drought by about 13.9 percentage points (p-value<0.01). As before, the coefficient on the size of a town's lending relative to its out-of-state neighbors is small and statistically insignificant (p-value=0.83). This coefficient is also statistically different from the corresponding in-state coefficient (p-value=0.08). As a robustness test, column 6 of Table 7 Panel A directly includes a town's loans per capita, along with these in-state and out-of-state ratios, with little qualitative change in estimates.

If credit availability indeed shaped the demographic impact of the drought, then towns with smaller ex-ante credit constraints should also experience a relatively larger increase in drought-related lending, as in-town banks expand credit supply in order to meet drought-related credit demand. Moreover, if nearby in-state centers of finance are close substitutes for in-town lending, then mirroring the population results, we should also expect a smaller increase in lending among drought exposed in-town banks when these towns are located near relatively larger sources of in-state finance that can also compete to meet the credit needs of the local population. And in parallel with the population results, the legal, regulatory and other border frictions should mute the impact of out-of-state sources of finance on the loan response of in-town banks to the drought.

The dependent variable in column 1 of Table 7 Panel B is the change in town-level bank lending between 1950 and 1960 scaled by total town-level bank assets in 1950. As in the panel, we continue to allow the impact of drought exposure to depend on the size of the in-state and out-of-state population, and include third order polynomials measuring separately the average distance between a reference town and its in-state neighbors, and the average distance between a reference town and its out-of-state neighbors.

Column 1 shows that drought-exposure is associated with increased bank lending in towns with greater ex-ante credit access. A one standard deviation increase in loans per capita in 1950 is associated with a 7 percentage point increase in lending among drought exposed towns (p-value=0.07). There is also evidence that in-state centers of finance are close substitutes for in-town lending. A one standard deviation increase in loans per capita among nearby in-state towns suggests an 11.7 percentage point smaller loan response to the drought among in-town banks (p-value<0.01). The coefficient on equidistant out-of-state loans is not significantly different from zero (p-value=0.21), but significantly different from its in-state counterpart (p-value<0.01).

To understand the importance of a town's credit constraints relative to its in-state and of out-of-state neighbors, column 2 of Table 7 Panel B scales in town loans per capita by nearby in-state loans and separately by equidistant out-of-state loans, and allows the impact of the drought to depend on these measures of relative ex-ante credit constraints. The evidence shows that the relative size of the local in-state banking market mediated the loan response to the drought. Drought-exposure is associated with increased bank lending in towns where lending frictions are relatively smaller than their nearby in-state neighbors. A one standard deviation increase in the ratio of in-town to in-state loans per capita implies a 17.6 percentage point increase in loan growth among drought exposed towns. The coefficient on the counterpart to the out-of-state variable is not significantly different from zero (p-value=0.20), but is significantly smaller than the in-state variable (p-value=0.07).

Finally, this evidence using the 1950-1960 cross-section might reflect "pre-trends" in bank lending rather than the local banking system's supply response to the drought. To address this, column 3 replicates the specification in column 2, but for lending growth between 1940 and 1950—the decade before the drought. The drought indicator variable, along with the credit-related interaction terms are individually and jointly insignificant.

6. Implications and Conclusion

We have shown that the availability of credit facilitates agricultural adaptation to drought, primarily by enabling investment in irrigation. This preserves local livelihoods, which not only limits outmigration but also encourages in-migration.

These results are supportive of the importance of the availability of funding for adaptation investment if communities are to survive climatic calamities – an issue that rightly concerns poorer countries as they face climate change. To the extent that the provision of financing helps unaffected communities in rich countries avoid waves of uncontrolled climate-induced immigration, unaffected communities too have an interest in providing that financing; perhaps more so because we also find that inequality in access to finance can actually exacerbate outmigration, from finance-poor communities to finance-rich communities.

Another important implication comes from our method of identification. If the local banking system is undiversified, as were the unit banks, it may prove unable to provide credit in the face of a massive calamity like the drought since its banks too will be hit. This again is important for developing countries where diversification in the local financial system needs to be encouraged so that it is healthy enough to facilitate credit flows when large-scale calamities hit.

As we have shown, the Texas drought did not constitute a permanent change in weather conditions, and there was plentiful groundwater available over the course of the drought. Climate change may have a more permanent character, and groundwater resources could be depleted over time. Nevertheless, there could be other ways of adapting, including financing a shift away from agriculture. Broadening access to finance may be really important to ensure the bulk of the change takes place through local adaptation, preserving local communities and relationships, rather than through migration, which entails costs for the communities left behind, for migrants, as well as for receiving communities. At the very least, finance allows more choice, and can be an important aid as we face up to the challenge of climate change.

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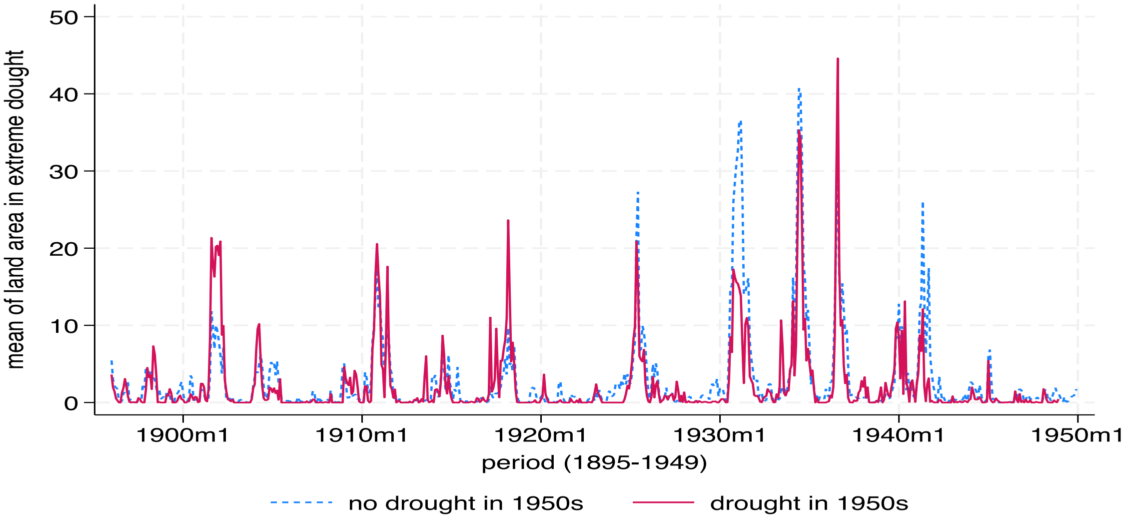
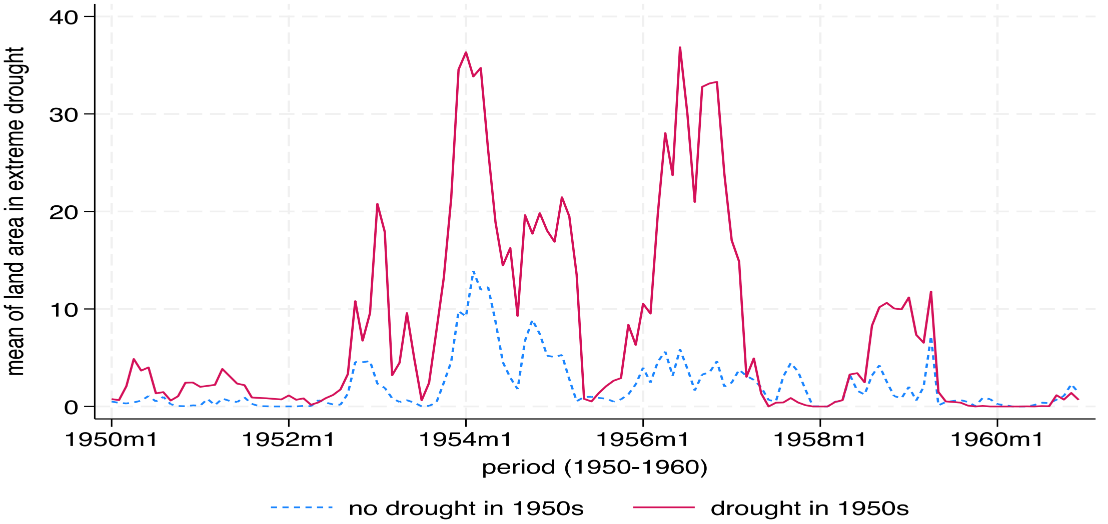
Figures and Tables

Figure 1 The mean monthly percent of land area in extreme drought

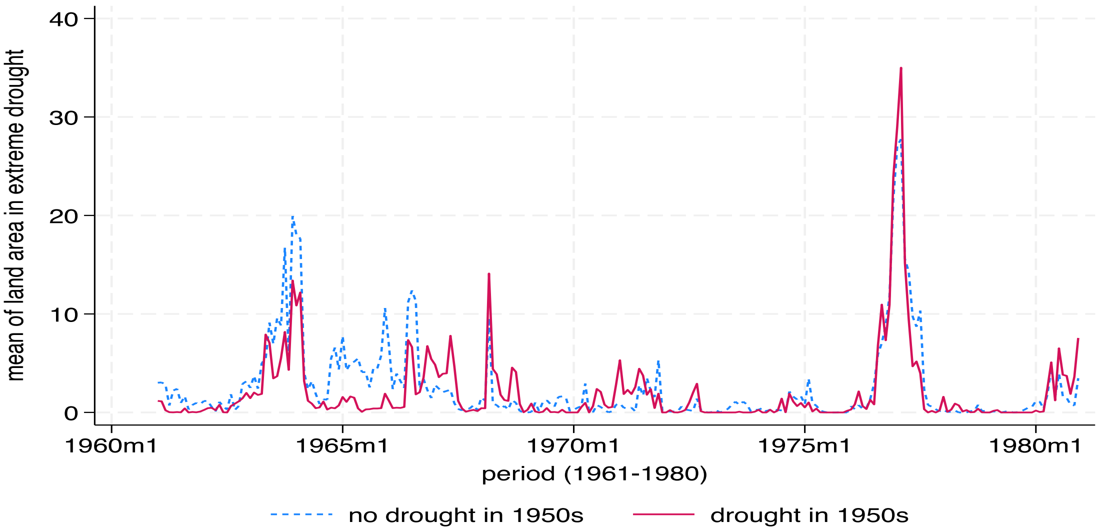
Panel A. 1895-1949



Panel B. 1950-1960

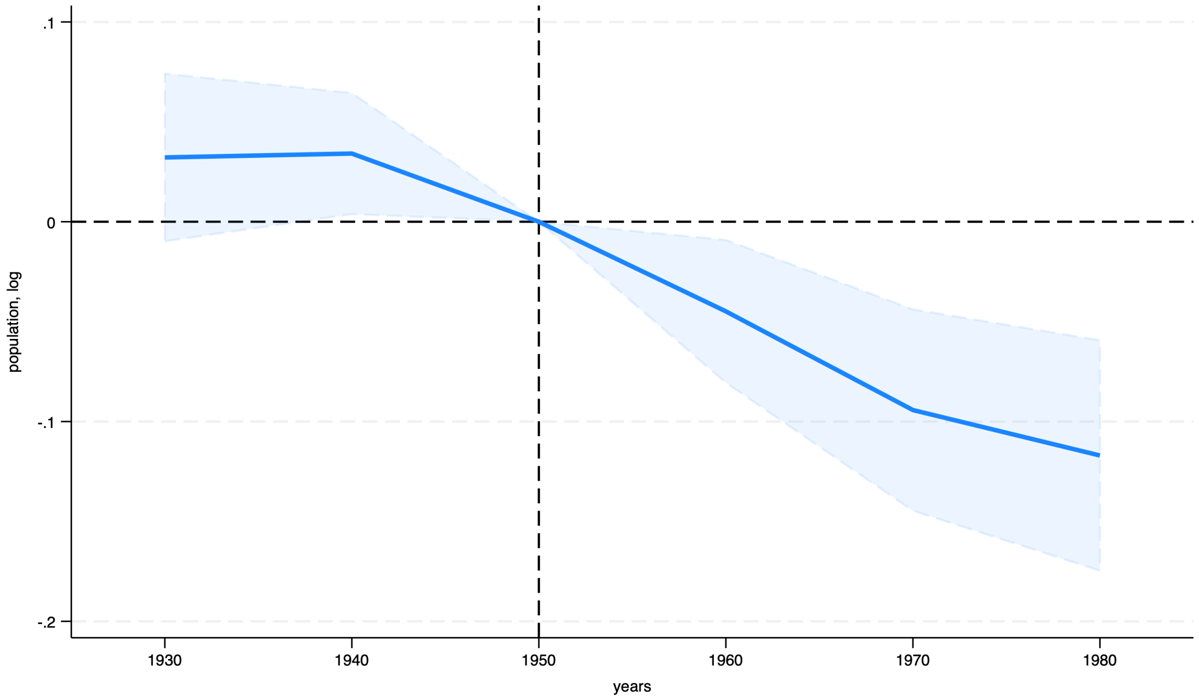


Panel C. 1960-1980



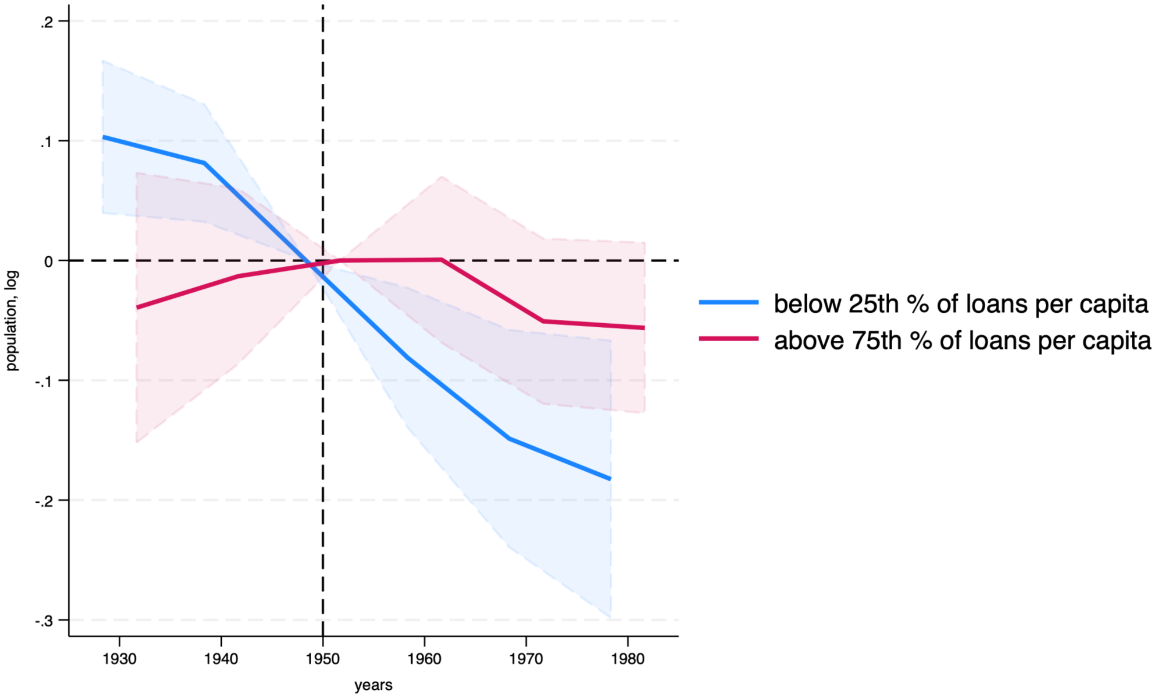
Notes: We use the 993 counties in the stratified sample to compute the mean percent of a county's land area in extreme drought in each year-month observation separately for those counties that were in the top-quartile of drought exposure in 1950-1960, and those counties outside the top-quartile. Panel A plots the two monthly time series for the period before the 1950s drought (1895-1949); Panel B plots the two monthly time series for 1949-1959 (the "1950s drought"; Panel C plots these series for 1960-1980

Figure 2 The impact of drought exposure on population at the county-level, 1930-1980



This figure reports the coefficients from an event study analysis. The dependent variable is the log population observed at the county-level each decade from 1930 through 1980. This variable is regressed on an indicator variable that equals 1 if a county had top quartile of drought exposure during the 1950s and 0 otherwise. The drought indicator variable is also interacted with year indicator variables for 1930; 1940; 1960; 1970 and 1980. 1950 is the omitted category. The figure reports the point estimates and 95% confidence bands (shaded region) for these coefficients. The regression also includes state by decade fixed effects, and standard errors are clustered at the state-level. The average impact of drought exposure pre 1950 is 0.0331 (p-value=0.07) and from 1960-1980 is -0.085 (p-value<0.00). These differences result in a difference-in-difference point estimate equal to -0.1185 (p-value<0.00).

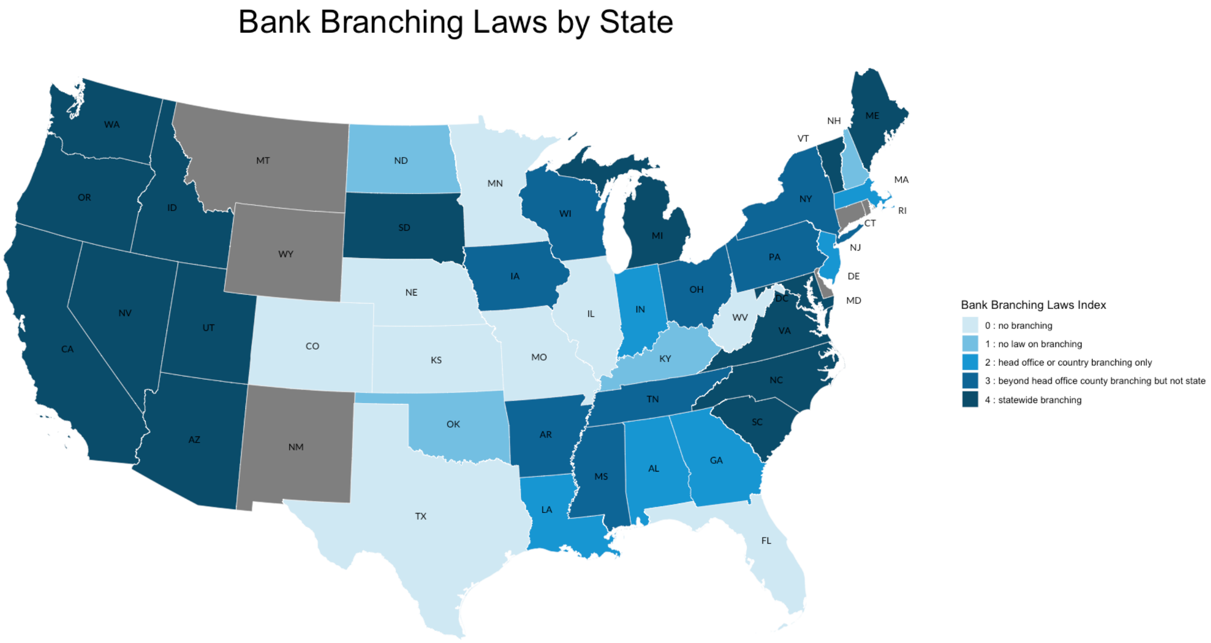
Figure 3 The impact of drought exposure on population at the county-level, by ex-ante credit, 1930-1980



This figure reports the coefficients from an event study analysis. The dependent variable is the log population observed at the county-level each decade from 1930 through 1980. This variable is regressed on an indicator variable that equals 1 if a county had top quartile drought exposure during the 1950s and 0 otherwise. The drought indicator variable is also interacted with year indicator variables for 1930; 1940; 1960; 1970 and 1980; 1950 is the omitted category. The regression also includes triple interaction terms, interacting top-quartile drought exposure; the year indicator variables, and an indicator variable that equals 1 if a county is below the 25th percentile of loans per capita, 1950. The figure reports the point estimates and 95% confidence bands (shaded region) for these coefficients. The regression also includes state by decade fixed effects, and standard errors are clustered at the state-level. The regression excludes counties between the 25th and 75th percentiles of loans per capita.

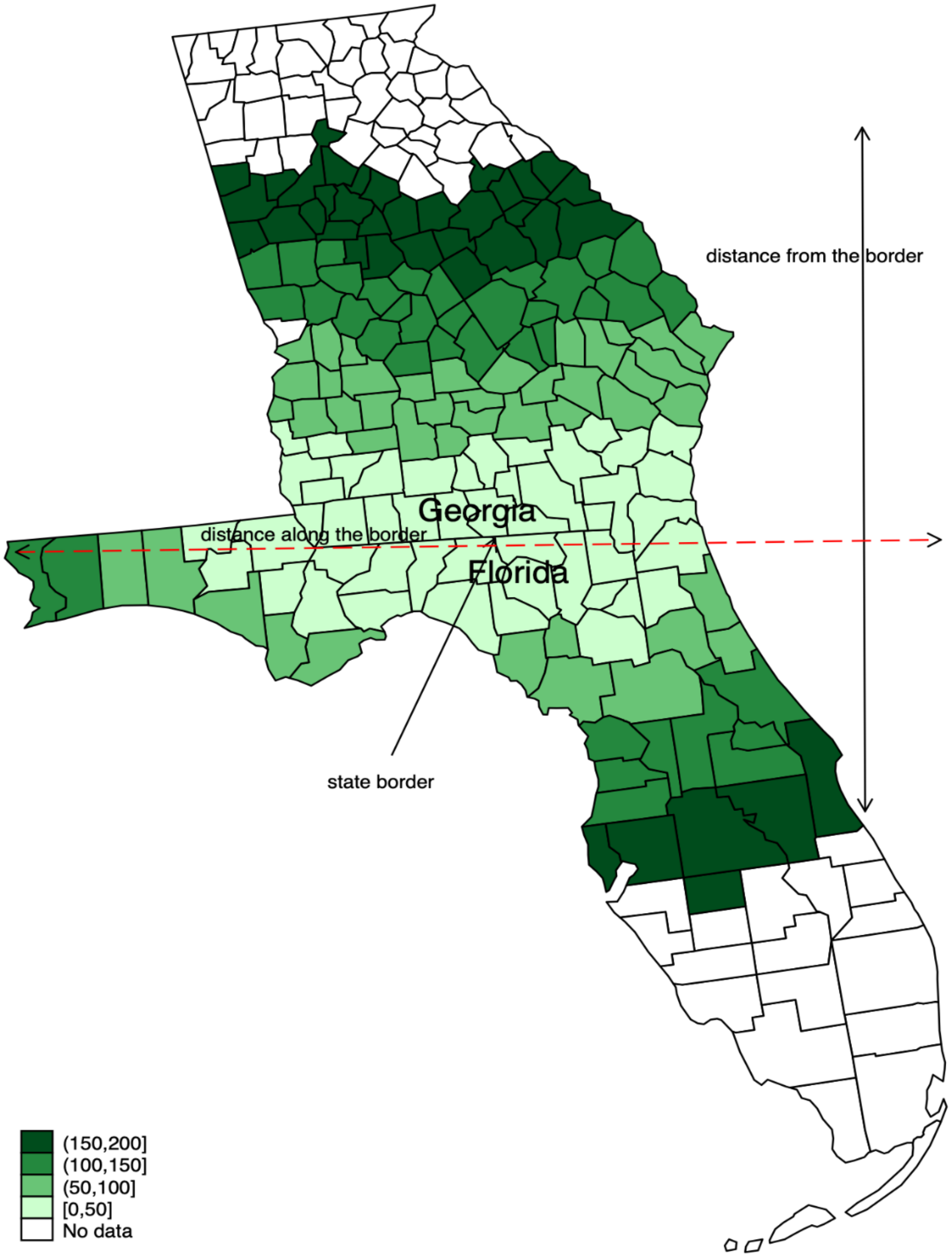
Figure 4 Bank Branching Laws, 1937

Panel A. Bank Branching Laws



Source: https://fraser.stlouisfed.org/title/branch-group-banking-685 Note that we do not have bank-level data for MT, WY and NM.

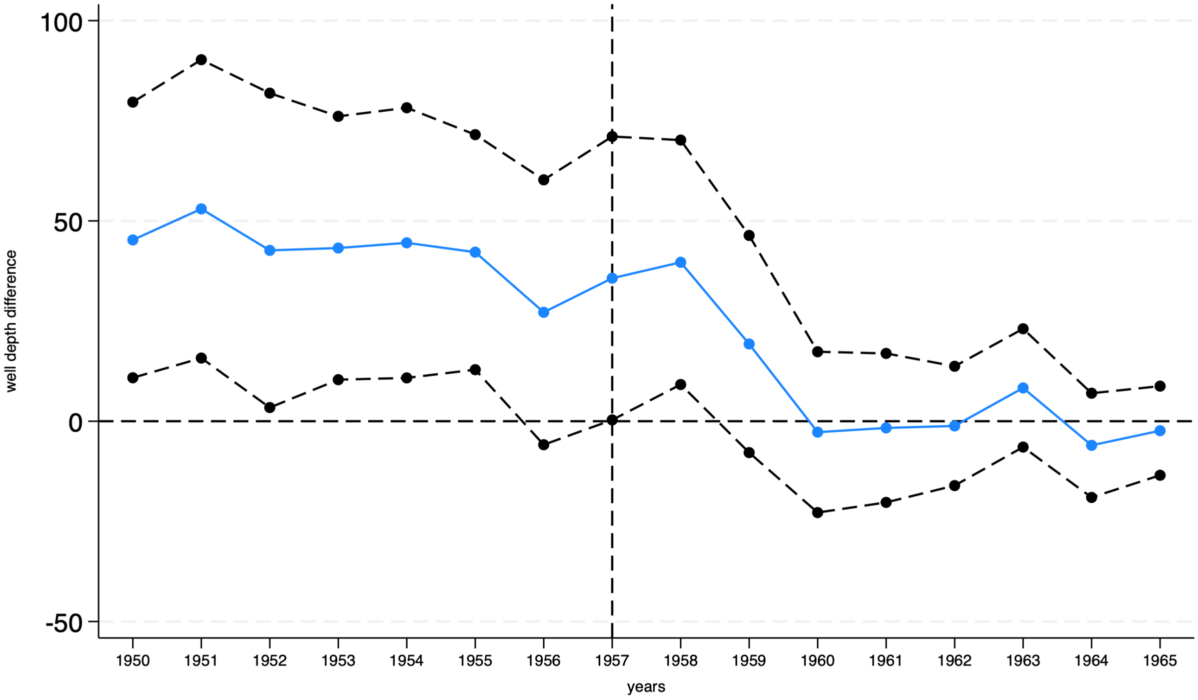
Panel B. Georgia-Florida Border



This figure illustrates the state border research design in Table 4 using the Georgia (GA) and Florida (FL) state border. GA was a branching state and FL was a unit banking state. The research design restricts the set of banks to those located in counties no further than 200 miles from the state border along a north-south orientation. Counties with lighter shading are closer to the border. Unshaded counties are excluded from the sample. The border also varies from east to west (dotted line), and the research design controls for this distance along the border—0 for those closest to the Atlantic and 261 miles for those furthest west—using a 3rd order polynomial. It also controls linearly for a county's distance from the border—0 to 200 miles.

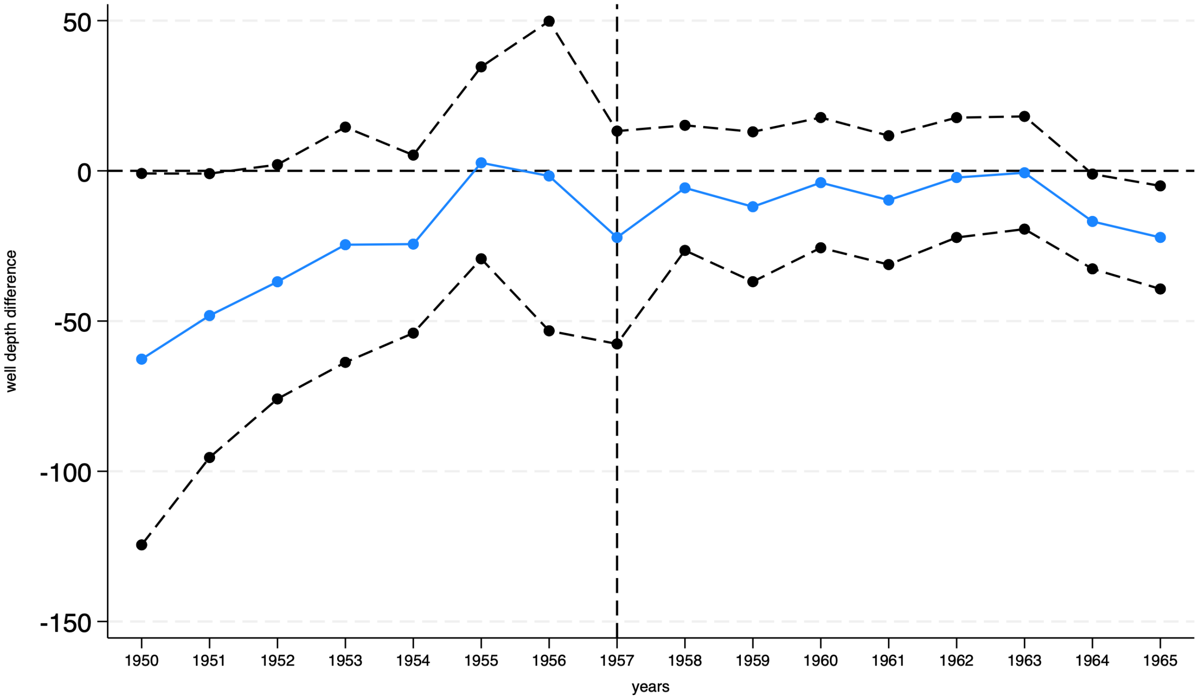
Figure 5. The difference in well-depth between counties at the 90th and 10th percentiles of loans per acre, 1950-1965, all states

Panel A. All states



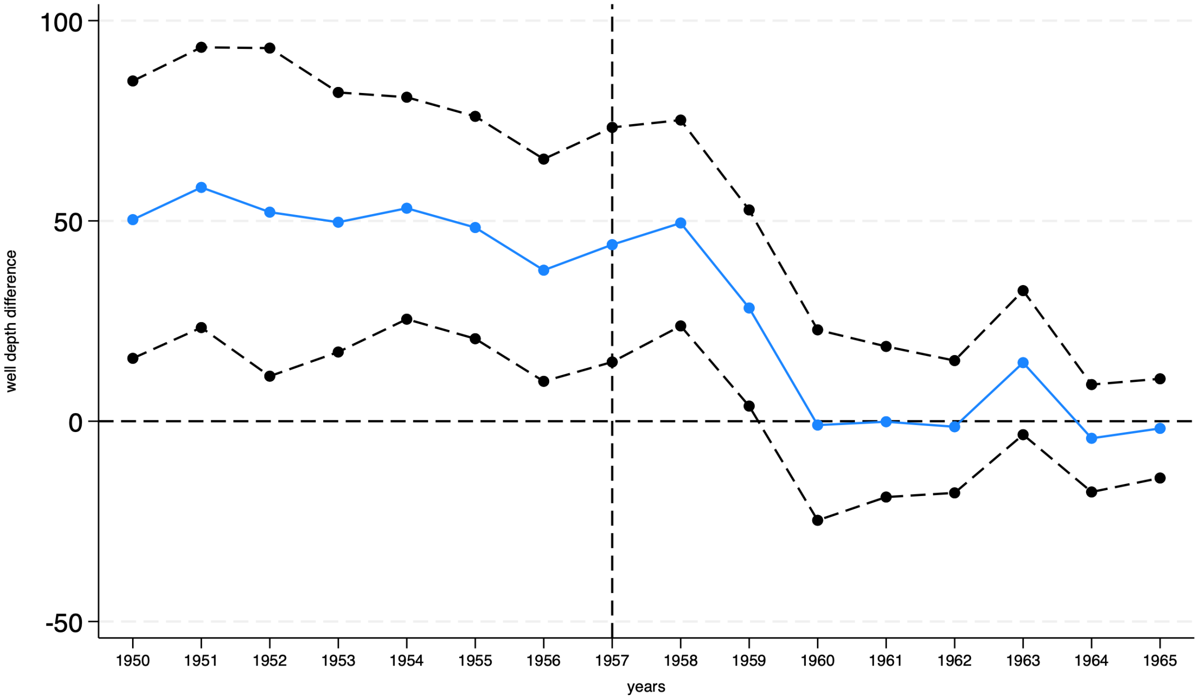
This figure plots the coefficients—solid line—along with the 95% confidence bands—dashed lines—for the average difference in well depth in each year between a county at the 90th percentile of bank credit (loans per acre) and a county at the 10th percentile of bank credit. The regression includes county and year fixed effects and standard errors are clustered at the county-level. The sample period is 1950-1970, the dependent variable is well depth (in feet) observed on a given date, and the dataset consists of an unbalanced panel of about 106,000 wells. The drought began at various locations beginning around 1947 and ended around 1957 for many counties. Panel A includes all states.

Panel B. Unit banking states



Panel B replicates the analysis in Panel A using only unit banking states.

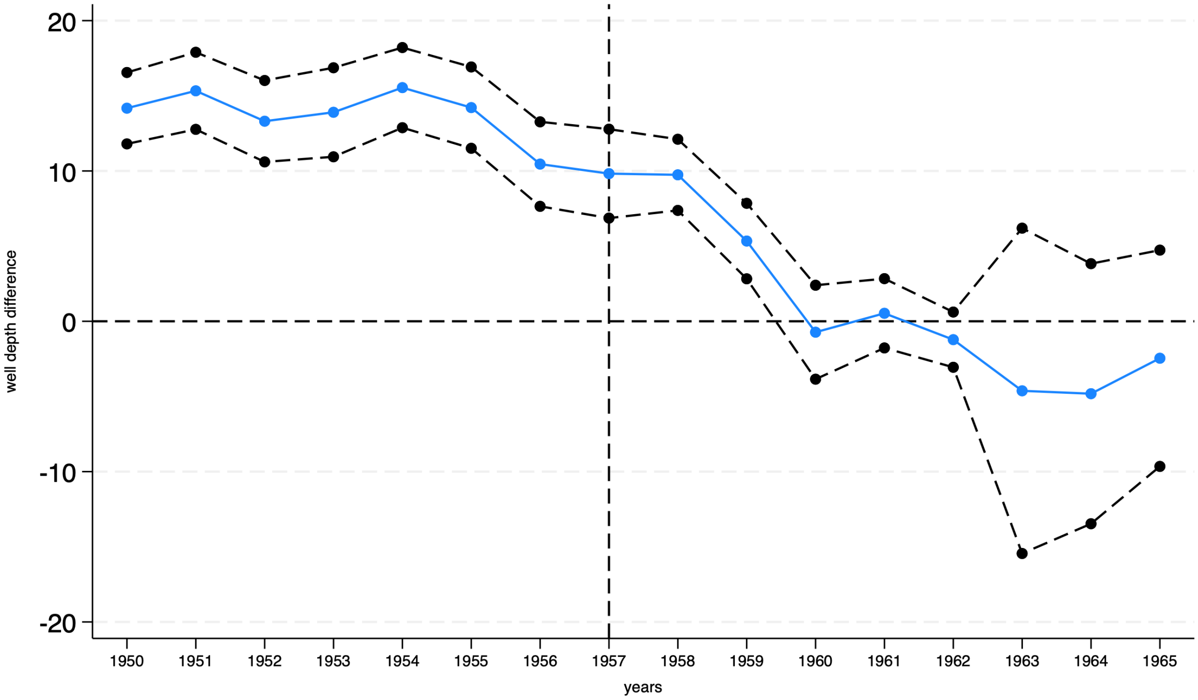
Panel C. Branch banking states



Panel C replicates the analysis in Panel A using only states that permit some form of branching.

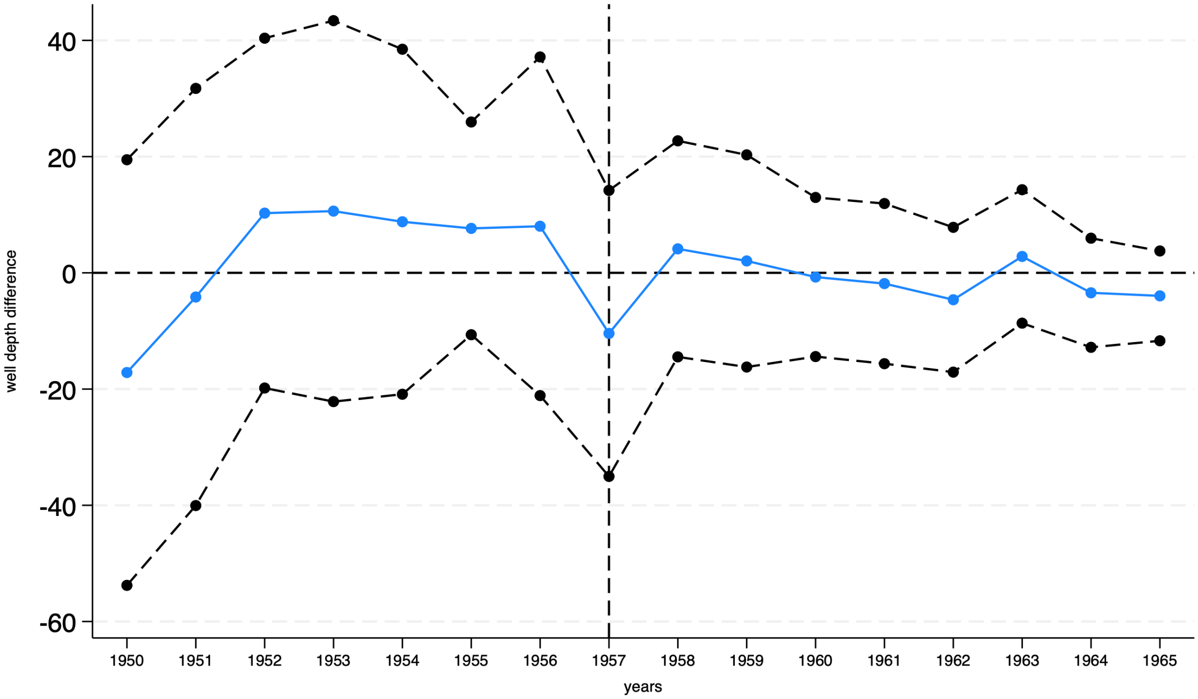
Figure 6. The difference in well-depth between counties at the 90th and 10th percentiles of banks per square mile, 1950-1965

Panel A. All states



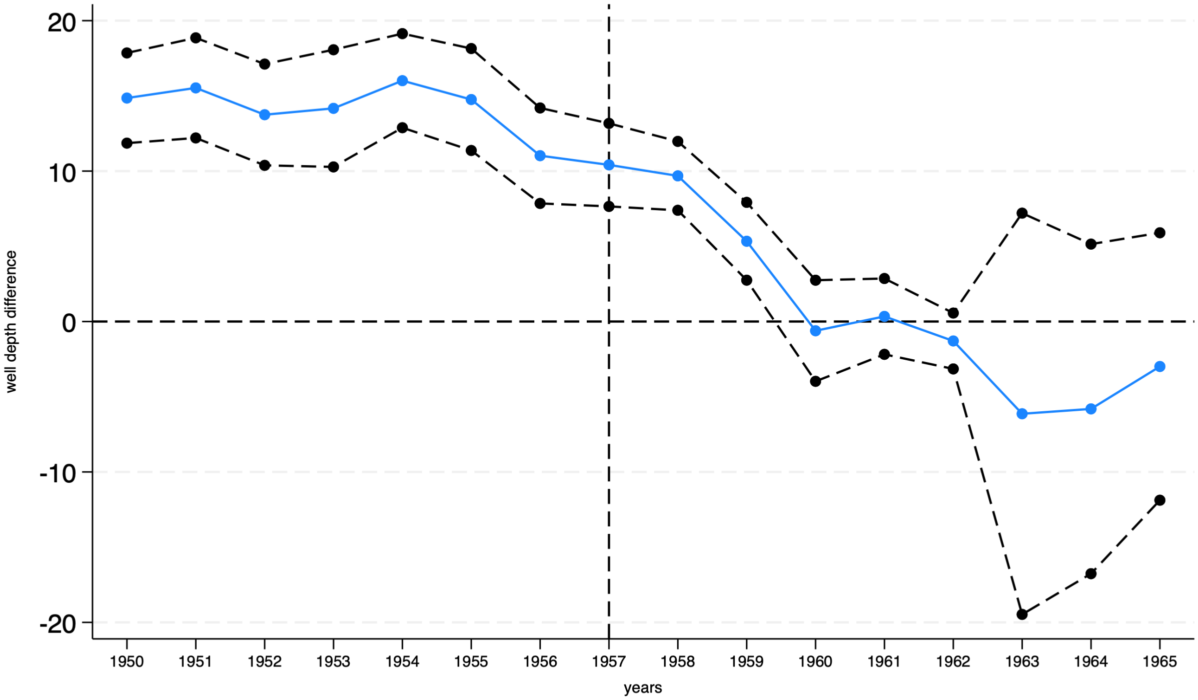
This figure plots the coefficients—solid line—along with the 95% confidence bands—dashed lines—for the average difference in well depth in each year between a county at the 90th percentile of bank credit availability (banks per square mile) and a county at the 10th percentile of bank credit availability. The regression includes county and year fixed effects and standard errors are clustered at the county-level. The sample period is 1950-1970, the dependent variable is well depth (in feet) observed on a given date, and the dataset consists of an unbalanced panel of about 106,000 wells. The drought began at various locations beginning around 1949 and ended around 1957 for many counties. Panel A includes all states.

Panel B. Unit banking states



Panel B replicates the analysis in Panel A using only unit banking states.

Panel C. Branch banking states



Panel C replicates the analysis in Panel A using only states that permit some form of branching.

Tables

Table 1. Bank credit availability, 1950

Panel A. Summary statistics

	Loans per capita	Number of banks per square mile	Population
	County-level		
Mean	115.04	0.004	94817
Std.dev	333.72	0.009	560392
	Town-level		
Mean	568.1	0.74	29,093
Std.dev	2683.5	0.94	159,068

This table reports summary statistics for loans per capita and the number of banks per square mile. The data on loans are available for 1,263 towns in 1950 and among the 993 counties in which these towns are located. The underlying data are hand-collected bank balance sheet information for each bank in the sample of towns—about 3,015 banks in total. Note that overall data collection includes 5,621 banks in 1929; 2,985 banks in 1939; 3,027 banks in 1960 and 4,148 banks in 1970. The data on the number of banks in each county is kindly provided by Matthew Jaremski and is available for 3,067 counties only in 1950.

Panel B. Correlations

	(1) loans per capita, log 1950	(2) loans per farm, log 1950	(3) loans per acre in agriculture, log 1950
banks per square mile in the county, 1950	2.882^{**}	4.165^{**}	5.194^{**}
	(1.206)	(1.868)	(2.538)
R-squared	0.109	0.217	0.341
Obs	981	981	981

This table reports the regression of loans in 1950, scaled by population (column 1); farms (column 2); and acreage in agriculture (column 3) in the county on the number of banks per square mile in 1950. All regressions include state fixed effects. Standard errors in parentheses and are clustered at the state level * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2. Ex-Ante Measures at the County-Level (1950) and Drought Exposure (1950-1960), Stratified Sample

Panel A. Balance tests with state fixed effects

	(1) log credit per capita, 1950	(2) number of banks per square mile, 1950	(3) log deposits per capita, 1950	(4) log median income, 1950	(5) log farm size, 1950	(6) log number of farms, 1950	(7) share of land in irrigation, 1949	(8) value of farm production per acre, 1950	(9) county area, ln
drought exposure	0.0591	-0.000720	-0.0135	-0.0463	0.0998	-0.0769	0.000624	-0.0810	-0.0167
	(0.113)	(0.000608)	(0.0323)	(0.0314)	(0.0906)	(0.0797)	(0.00803)	(0.100)	(0.0309)
N	993	991	992	993	985	986	971	983	991
adj. R^2	0.076	0.263	0.118	0.501	0.610	0.269	0.413	0.450	0.488

Panel B. Balance tests with state fixed effects and log population in 1950

	(1) log credit per capita, 1950	(2) number of banks per square mile, 1950	(3) log deposits per capita, 1950	(4) log median income, 1950	(5) log farm size, 1950	(6) log number of farms, 1950	(7) share of land in irrigation, 1949	(8) value of farm production per acre, 1950	(9) county area, ln
drought exposure	0.0699	0.000371	0.0258	-0.00861	0.0234	-0.0276	0.00199	-0.000959	-0.0156
	(0.112)	(0.000550)	(0.0360)	(0.0326)	(0.0713)	(0.0670)	(0.00774)	(0.0857)	(0.0298)
N	993	991	992	993	985	986	971	983	991
adj. R^2	0.076	0.338	0.180	0.657	0.706	0.324	0.418	0.552	0.488

Panel C. Balance tests with log population in 1950

	(1) log credit per capita, 1950	(2) number of banks per square mile, 1950	(3) log deposits per capita, 1950	(4) log median income, 1950	(5) log farm size, 1950	(6) log number of farms, 1950	(7) share of land in irrigation, 1949	(8) value of farm production per acre, 1950	(9) county area,ln
drought	0.0446	0.000509	0.0375	-0.0123	0.181	0.00831	0.00460	0.0689	0.0177
exposure	(0.0796)	(0.000603)	(0.0385)	(0.0457)	(0.149)	(0.0836)	(0.00940)	(0.132)	(0.0847)
N	993	991	992	993	985	986	971	983	991
adj. R^2	-0.002	0.171	0.067	0.144	0.338	0.069	-0.000	0.221	0.010

These panels regress a variety of demographic and economic variables—the column headings—(all observed on or pre-1950) on an indicator variable that equals 1 if a county is in the 4th quartile of drought intensity, 1950-1960 using the sample of counties with bank balance sheet data (stratified sample)—Table IA A1.3 repeats this exercise for the comprehensive sample. Panel A uses only state fixed effects as controls; Panel B includes both state fixed effects and log population in 1950, and Panel C only controls for log population in 1950. Standard errors (in parentheses) are clustered at the state-level: $^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$

Table 3 The impact of drought exposure on county-level log population, 1930-1980

Dependent Variable: The log of population

	(1)	(2)	(3)	(4)	(5)
drought exposure	-0.108***	-0.655	-1.302	-1.534	-2.095**
	(0.0293)	(1.492)	(1.899)	(1.918)	(0.911)
drought exposure#log loans per capita, 1950		0.0331*	0.0457**		
		(0.0176)	(0.0201)		
drought exposure#banks per square mile, 1950				0.0145**	0.00891**
				(0.00614)	(0.00428)
drought exposure*area		-0.0160	0.0958*	0.154**	0.0866**
		(0.0416)	(0.0542)	(0.0575)	(0.0379)
drought exposure*bank deposits		-0.100	-0.185	-0.205	-0.216***
		(0.131)	(0.157)	(0.156)	(0.0650)
drought exposure*median income		0.0663	0.0239	0.0132	0.149
		(0.192)	(0.229)	(0.231)	(0.118)
R-squared	0.373	0.600	0.968	0.968	0.942
Obs	5928	5922	5922	5916	20769
Fixed effects	state#year	state#year	county & year	county & year	county & year

This table examines the impact of drought exposure on the log of population in a decadal panel from 1930-1980. Columns 1-3 measure ex-ante credit availability using loans per capita, available for about 993 counties in the stratified sample. Column 4 uses the stratified sample, including those counties that have data on both loans per capita and banks per square mile, while column 5 uses the comprehensive sample, which consists of about 3000 counties in the panel. In all columns, the dependent variable is the log population observed in each decade. Drought exposure equals 1 from 1960-1980 if a county was in the top-quartile of drought exposure in the 1950s, and 0 otherwise. Standard errors in parentheses and are clustered at the state level * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Loan growth, drought exposure, and bank branching, the bank-level evidence, 1950-1960.

Dependent variable: Change in loans 1950-60/ Bank assets 1950

	(1)	(2)	(3)	(4)	(5)
drought exposure	-0.0795***	-0.105	-0.219	0.909	0.886
	(0.0265)	(0.358)	(0.785)	(0.860)	(0.746)
drought exposure x branching	0.0694**	0.0984***	0.0656*	0.0606***	0.0741***
	(0.0339)	(0.0312)	(0.0374)	(0.0211)	(0.0236)
loans and discounts/assets	0.586***	0.719***	0.640***	0.282	0.288
	(0.208)	(0.234)	(0.213)	(0.189)	(0.173)
capital and profits/assets	1.339	1.314	0.346	2.594*	2.350*
	(1.250)	(1.515)	(1.615)	(1.406)	(1.261)
deposits/assets	0.0895	0.0146	0.0612	0.316	0.355
	(0.253)	(0.308)	(0.295)	(0.328)	(0.267)
log bank assets	0.0293***	0.0303**	-0.0325	-0.0296*	-0.0256
	(0.00935)	(0.0120)	(0.0246)	(0.0154)	(0.0153)
drought x loans		-0.599**	-0.577**	-0.475*	-0.420*
		(0.234)	(0.239)	(0.259)	(0.218)
drought x capital		0.119	-0.619	-2.066	-1.630
		(1.848)	(2.176)	(1.405)	(1.429)
drought x deposits		0.276	0.191	-0.155	-0.0332
		(0.360)	(0.348)	(0.366)	(0.316)
drought x assets		-0.00412	-0.0294	-0.0261	-0.0321
		(0.0166)	(0.0524)	(0.0450)	(0.0371)
log income in county			0.159*	0.305***	0.283***
			(0.0888)	(0.106)	(0.0868)
drought exposure x log income			0.0471	-0.0633	-0.0764
			(0.0781)	(0.0835)	(0.0716)
rural population share in county			-0.0435	-0.0187	-0.0441
			(0.0743)	(0.0595)	(0.0503)
drought x rural			0.129	0.160**	0.181***
			(0.0962)	(0.0693)	(0.0540)
mean farm size in county			0.00720	-0.0451	-0.0399
			(0.0343)	(0.0691)	(0.0544)
drought x farm size			-0.0234	0.0207	-0.0385
			(0.0346)	(0.0644)	(0.0735)
log population in county			0.0297*	0.0170**	0.0152**
			(0.0169)	(0.00645)	(0.00642)

drought x population			0.0208	0.0212	0.0291
			(0.0304)	(0.0263)	(0.0216)
R-squared	0.142	0.151	0.183	0.184	0.175
Obs	1730	1730	1730	2425	2952

This table examines the role of branching regulations in mediating the impact of drought exposure on bank lending using the stratified sample. The dependent variable is a bank's change in loans between 1950 and 1960 divided by the bank's assets in 1950--the unit of analysis is at the bank level. Column 1 uses only bank-level controls, while column 2 interacts the bank-level controls with the drought indicator variable. Column 3 interacts all control variables with the drought exposure indicator variable. Column 4 restricts the sample to counties no further than 200 miles from a border between a unit banking and a state that legally allowed some form of branching. Column 5 restricts the sample to counties no further than 200 miles from a border between a unit banking and all other states: both those that legally allow some form of branching and those that had no explicit branching laws; column 5 classifies the latter is “branching states”. All columns include state fixed effects; columns 4 and 5 also includes border fixed effects. Standard errors are clustered at the state-level. Columns 4 and 5 cluster at the border-level. Note that the variable “drought exposure x branching” is robust to clustering at the state or at the bank-level in columns 4 and 5.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5. Well depth, drought exposure, and credit availability

Dependent variable: The depth of an irrigation well

	(1) loans per acre	(2) loans per acre	(3) banks per square mile	(4) banks per square mile	(5) banks per square mile: border
drought exposure	-8.921**	-5.483	-25.50***	-26.56***	-19.57***
	(4.002)	(4.965)	(5.804)	(8.927)	(4.789)
drought exposure#loans per acre, log, 1950	5.336***	5.655***			
	(1.060)	(0.588)			
drought exposure#unit		2.848		10.91	3.075
		(6.014)		(9.837)	(6.711)
drought exposure#loans per acre, log, 1950#unit		-8.839***			
		(1.868)			
drought exosure#banks per square mile, log, 1950			15.03***	17.15***	14.67***
			(2.735)	(2.924)	(1.351)
drought exposure#banks per square mile, log, 1950#unit				-10.29**	-6.911*
				(4.764)	(3.661)
R-squared	0.488	0.489	0.506	0.506	0.604
Obs	740130	740130	1776195	1776195	1820498
Fixed effects	county & year	county & year	county & year	county & year	county, border & year
Marginal impact of drought exposure (standard error)					
10th percentile of credit in a **branching state**		-8.72		-23.68***	-11.59***
		(5.23)		(8.464)	(4.24)
10th percentile of credit in a **unit banking state**		-0.811		-14.50***	-12.27***
		(5.68)		(5.09)	(4.21)
90th percentile of credit in a **branching state**		28.84***		16.44***	13.18***
		(3.09)		(3.08)	(3.09)
90th percentile of credit in a **unit banking state**		-21.96**		1.54	0.83
		(9.23)		(6.06)	(4.39)

This table studies the impact of drought exposure on well-depths over the period 1950-1970. The dependent variable is the depth of a well. Drought equals 1 if the county was in the top quartile of drought exposure between 1950 and 1960, and 0 otherwise. Unit equals 1 if a state prohibited branch banking, and 0 otherwise. All regressions include county and year fixed effects. Column 5 also includes border fixed effects. Column 5 restricts the sample to counties no further than 200 miles from a state border that has unit banking on one side of the border and branching on the other side of the state border. Column 5 also includes linearly a county's distance from a state border, as well as a county's distance along a state border using a third order polynomial. Standard errors in parentheses and are clustered at the county level * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6. More on Adaptation

Panel A Agricultural adaptation

Dependent variable	(1) log change in irrigated acreage , 1949-1959 (all farmland)	(2) log change in sorghum acreage, 1949-1959	(3) log change in output per farm, 1959-1969
drought exposure	3.060	0.401	-0.580**
	(2.767)	(0.733)	(0.255)
drought exposure#banks per square mile, 1950	0.0332	-0.0432*	
	(0.0342)	(0.0223)	
drought exposure#unit banking state	-0.144	-0.308*	-0.0143
	(0.311)	(0.178)	(0.0614)
drought exposure#banks per square mile, 1950#unit banking	-0.0866*	0.0530**	
	(0.0476)	(0.0199)	
drought exposure#banks per acre, 1950			0.170
			(0.879)
drought exposure#banks per acre,1950#unit banking			-2.080**
			(0.907)
R-squared	0.339	0.377	0.616
Obs	2995	1943	3021

This table examines the impact of drought exposure on other forms of adaptation using the comprehensive sample in a county-level cross-sectional analysis over the decade 1950-60. All regressions include the log of a county's population and area (in 1950) interacted with drought exposure, as well as state fixed effects. Drought exposure equals 1 if a county was in the top-quartile of drought exposure in the 1950s, and 0 otherwise. Standard errors in parentheses and are clustered at the state level * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Panel B. Demographic Impact of the drought, 1960.

Dependent variable	(1) % migrants from a different county in 1960	(2) births per capita, 1960	(3) deaths per capita, 1960
drought exposure	1.375	-0.288	0.402^{**}
	(4.804)	(0.175)	(0.170)
drought exposure*banks per square mile	0.111	0.00151	-0.00556
	(0.173)	(0.00251)	(0.00345)
drought exposure*unit banking state	2.114	0.0597^{**}	-0.0423
	(1.579)	(0.0290)	(0.0320)
drought exposure*banks per square mile*unit banking state	-0.604^{**}	-0.0111^{**}	0.0124^{*}
	(0.293)	(0.00443)	(0.00682)
R-squared	0.312	0.493	0.492
Obs	3060	3060	3057

This table examines the demographic impact of the drought in the county-level cross-section, using the comprehensive sample. All regressions include county population and area (in logs) linearly and interacted with the drought exposure variable, along with state fixed effects. Columns 2 and 3 include the birth rate in 1950 and the death rate in 1950 respectively. Standard errors are clustered at the state level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Panel C. Population Dynamics

Dependent variable	(1) Log of population, 1930-1980
drought exposure	-1.256^{***}
	(0.398)
drought exposure#banks per square mile, 1950	0.0224^{***}
	(0.00782)
drought exposure#unit banking state	0.914
	(0.594)
drought exposure#banks per square mile, 1950#unit banking	-0.0266^{**}
	(0.0113)
R-squared	0.938
Obs	21484
Fixed effects	county & year

This table examines the impact of drought exposure on the log of population in a decadal panel of counties from 1930-1980 using the comprehensive sample. The dependent variable is the log population observed in each decade. Drought exposure equals 1 from 1960-1980 if a county was in the top-quartile of drought exposure in the 1950s, and 0 otherwise. Standard errors in parentheses and are clustered at the state level * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7. Spillovers--drought exposure at the town-level and state border discontinuities

Panel A. Population, town-level panel, 1930-1980

	(1)	(2)	(3)	(4)	(5)	(6)
			Border discontinuities			
drought exposure	-0.144^{***}	-1.030^{***}	-0.582	0.212	-1.431^{*}	-1.342^{*}
	(0.0390)	(0.340)	(0.837)	(0.736)	(0.704)	(0.701)
drought exposure#loans per capita,1950, log, in-town		0.142^{**}	0.159^{***}	0.0896^{*}		0.0193
		(0.0527)	(0.0521)	(0.0492)		(0.101)
drought exposure#loans per capita, 1950,log, in-state			-0.158^{**}	-0.128^{*}		
			(0.0721)	(0.0645)		
drought exposure#loans per capita, 1950,log, out-of-state			0.0302	-0.0745		
			(0.0484)	(0.0658)		
drought exposure#ratio of in-town to in-state loans per capita					0.997^{***}	0.928^{**}
					(0.337)	(0.453)
drought exposure#ratio of in-town to out-of-state loans per capita					-0.0778	-0.170
					(0.353)	(0.343)
R-squared	0.735	0.751	0.754	0.917	0.755	0.756
Obs	6861	6861	6861	6867	6861	6861
Fixed Effects	state#year	state#year	state#year	county & year	state#year	state#year
Difference between in-state and out-of-state coefficient (standard error)			-0.187^{**}	-0.054	1.074^{*}	1.099^{*}
			(0.08)	(0.09)	(0.59)	(0.58)

This table examines the impact of drought exposure on the log of population in a decadal panel of 1,170 towns from 1930-1980. The dependent variable is the log population observed in each decade. Drought exposure equals 1 from 1960-1980 if a town was located in a county with top-quartile drought exposure in the 1950s, and 0 otherwise. Column 2 interacts the drought exposure indicator with the log of loans per capita in 1950 in the town. Column 3 interacts the drought exposure indicator with the log of loans per capita computed among in-state towns no further than 200 miles away from the reference town, and separately loans per capita among equidistant out-of-state towns. Column 4 includes county and year fixed effects. Column 5 interacts drought exposure with the ratio of log loans per capita in the town to log loans per capita among in-state towns within 200 miles; the regression also interacts the log of loans per capita in the town to loans per capita among equidistant out-of-state towns. Column 6 includes the covariates from column 5 and adds an interaction term between drought exposure and log loans per capita in the town. All border regressions interact drought exposure with the log of the population in in-state and out-of-state towns. All regressions include a town's mean distance from its in-state and out-of-state neighbors using a third order polynomial, and interact drought exposure with a town's area. The subcomponents of all interactions terms are included. Standard errors in parentheses and are clustered at the state level * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Panel B. Credit growth, town-level cross-section

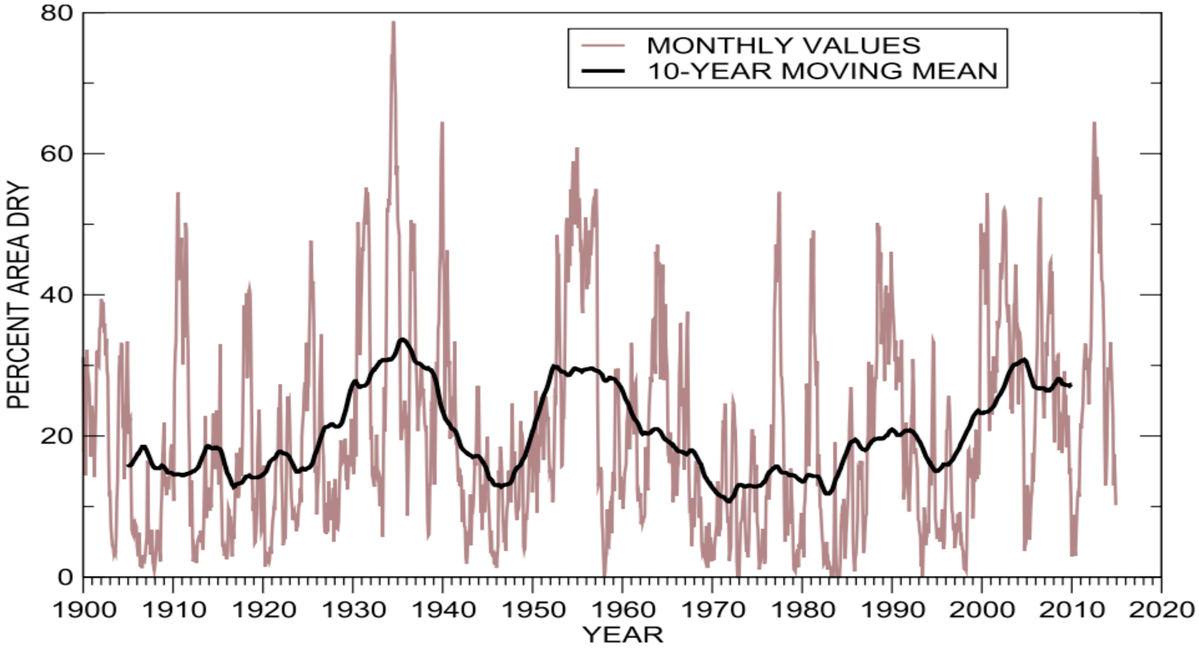
	(1)	(2)	(3)
	Border discontinuities		
	Loan growth, 1950-1960		Loan growth, 1940-1950
drought exposure	0.328	-1.042	20.04
	(0.683)	(0.722)	(13.08)
drought exposure#loans per capita,1950, log, in-town	0.0793*		
	(0.0435)		
drought exposure#loans per capita, 1950,log, in-state	-0.244***		
	(0.0656)		
drought exposure#loans per capita, 1950,log, out-of-state	0.0578		
	(0.0450)		
drought exposure#ratio of in-town to in-state loans per capita		1.029***	-2.138
		(0.344)	(3.815)
drought exposure#ratio of in-town to out-of-state loans per capita		-0.463	-9.231
		(0.320)	(7.342)
R-squared	0.121	0.119	0.071
Obs	1215	1215	1215
Difference between in-state and out-of-state coefficient (standard error)	-0.302***	1.49**	7.09
	(0.08)	(0.65)	(9.52)

This table studies the impact of drought exposure on credit growth in a cross-section of 1,215 towns. The dependent variable in columns 1 and 2 is the change in total loans in a town between 1950 and 1960 divided by total banking assets in the town in 1950. In column 3, this dependent variable is computed over 1940-1950. "Loans per capita, 1950,log, in-state" is the mean log loans per capita among towns located in the same state and within 200 miles from the reference town. "Loans per capita, 1950,log, out-of-state" is defined similarly, but for towns located across the state border from the reference town. All regressions also interact drought exposure with the population in the town in 1950, as well as the population among in-state towns up to 200 miles away, and the population in equidistant out-of-state towns. The subcomponents of all interaction terms are included as well. All regressions also include a reference town's average distance from its in-state neighbors, and its out-of-state neighbors. These two variables are included as a 3rd order polynomial. Columns 1-3 also include state-level fixed effects and standard errors in parentheses are clustered at the state level * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Internet Appendix

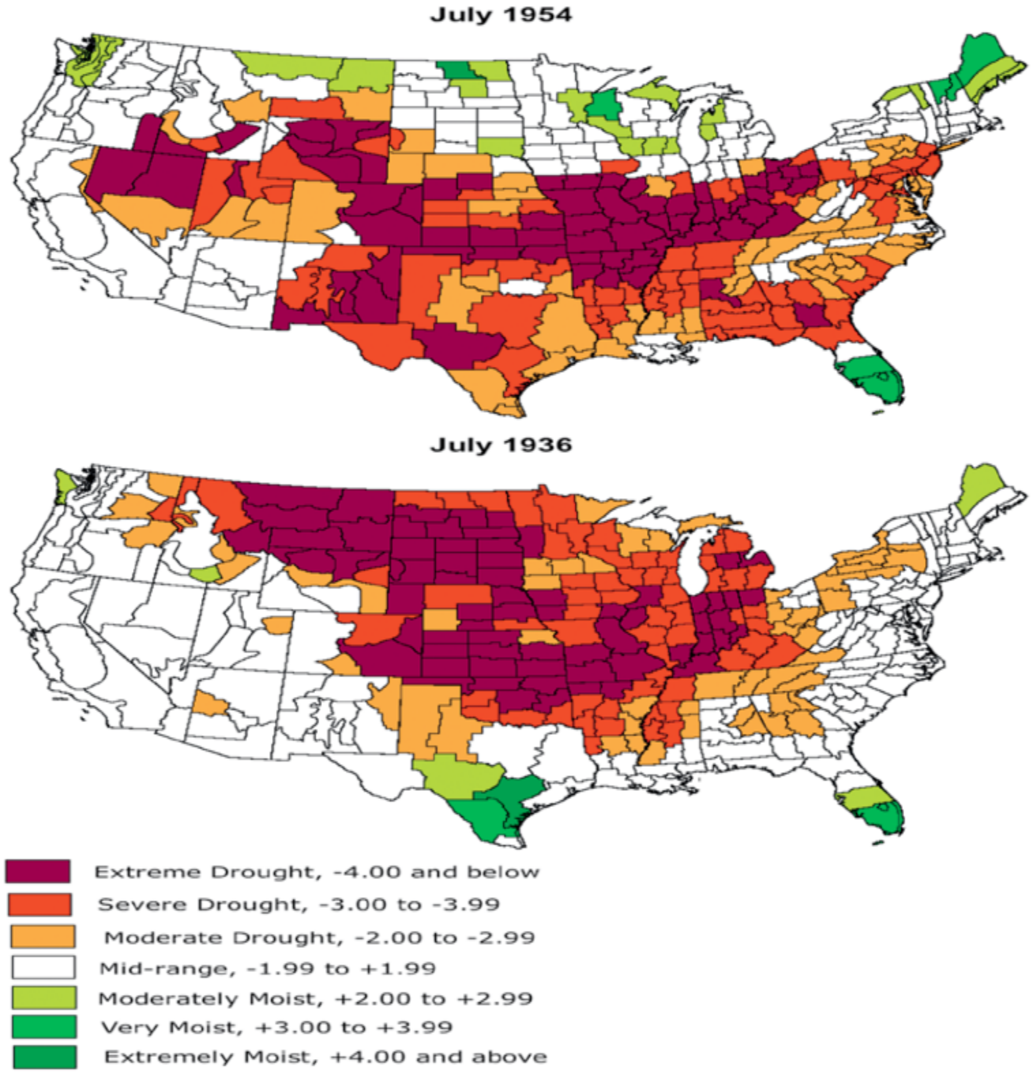
Appendix A1. Supplementary Figures and Tables

Figure A1.1 Drought in the continental United States, 1900-2014



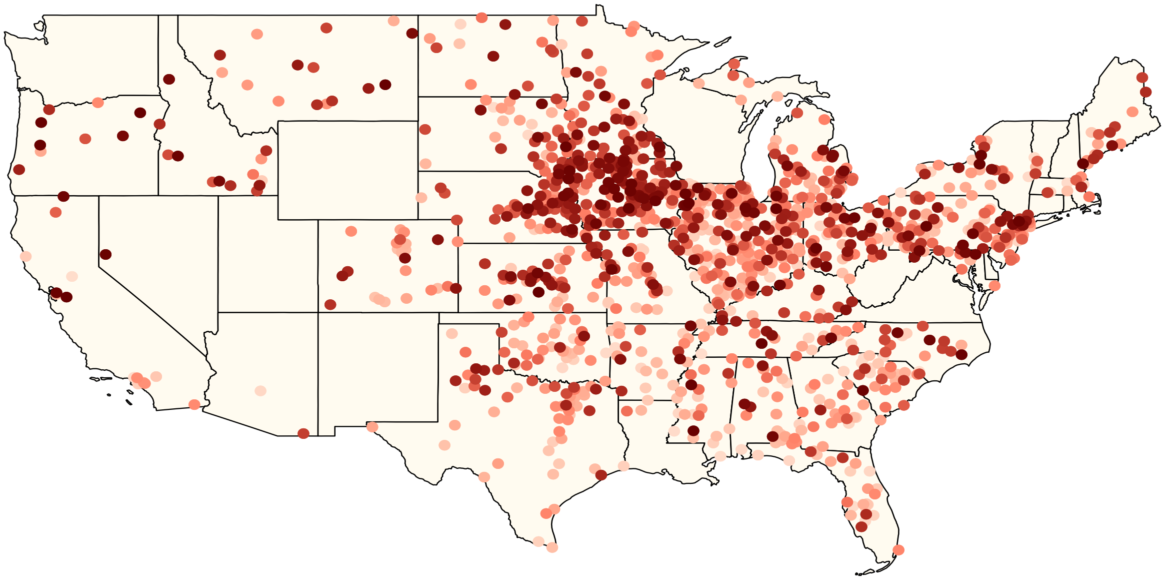
This figure shows the percent area of the continental US experiencing moderate to extreme drought (Palmer Drought Severity Index<-2.00) conditions, Jan 1900-Dec 2014. The black line is the 10 year moving average—see (Heim 2017). The Palmer Drought Severity Index (PDSI) is a single index that uses the water balance for a particular area—precipitation, evapotranspiration, runoff and soil moisture—to calculate local drought intensity. See https://climatedataguide.ucar.edu/climate-data/standardized-precipitation-index-spi for a short description of drought measures.

Figure A1.2 The “Dustbowl” and the 1950s drought



Notes: This figure plots drought intensity using the Palmer Drought Severity Index—see (Heim 2017).

Figure A1.3 Towns in the Sample



Notes: This figure shows the spatial distribution of the towns in the sample with bank-level data—the stratified sample.

Table A1.1 The share of a county's land area in extreme drought using the Standard Precipitation Index (SPI) during the Dustbowl and the 1950s drought, by census geographic region.

	Mean	SD	Min	Max
		New England		
1950s Drought	2.02	1.45	0	6.17
Dustbowl	2.37	1.31	0.01	5.55
		Mid-Atlantic		
1950s Drought	0.84	0.96	0	5.77
Dustbowl	4.44	2.91	0.03	13.57
		East North Central		
1950s Drought	2.8	2.08	0	8.62
Dustbowl	7.54	3.15	0.52	16.04
		West North Central		
1950s Drought	4.5	3.26	0	15.09
Dustbowl	5.67	3.14	0.05	16.52
		South Atlantic		
1950s Drought	2.33	1.88	0	7.68
Dustbowl	4.23	2.6	0	10.44
Table 1, cont'd				
		East South Central		
1950s Drought	2.54	1.82	0	8.22
Dustbowl	5.64	3.87	0	16.31
		West South Central		
1950s Drought	5.03	3.64	0	20.37
Dustbowl	1.37	1.53	0	9.42
		Mountain		
1950s Drought	4.01	3.13	0	18.3
Dustbowl	3.66	2.83	0	11.62
		Pacific		
1950s Drought	1.56	1.1	0.04	7.31
Dustbowl	4	3.29	0.01	13.03

The county-level data are from the National Oceanic and Atmospheric Administration

Table A1.2 Sources of farm credit, 1950

		Non-real estate		**Real estate**		**All**	
		$ (million)	%	$ (million)	%	$ (million)	%
Banks		2,048	39.9%	937	16.8%	2,985	27.9%
Merchants and Dealers		2,300	44.8%	0	0.0%	2,300	21.5%
Life Insurance Companies		0	0.0%	1,172	21.0%	1,172	10.9%
Individuals		0	0.0%	2,312	41.4%	2,312	21.6%
Non-market		784	15.3%	1,158	20.8%	1,942	18.1%
Total		5,132		5,579		10,711	

Source: Agricultural Credit and Related Data, 1968, American Bankers Association. Non-market sources include the Farmers Home Administration; Production Credit Associations and Federal Land Banks.

Table A1.3 Ex-Ante Measures at the County-Level (1950) and Drought Exposure (1950-1960), Comprehensive Sample

Panel A. Balance tests with state fixed effects

	(1) number of banks per square mile,1950	(2) log deposits per capita, 1950	(3) log median income, 1950	(4) log farm size, 1950	(5) log number of farms, 1950	(6) share of land in irrigation, 1949	(7) value of farm production per acre, 1950	(8) county area
drought exposure	-0.000260 (0.000237)	0.0118 (0.0308)	-0.0225 (0.0393)	0.211 (0.178)	-0.149 (0.116)	-0.00208 (0.00287)	-0.0565 (0.0882)	0.0190 (0.0461)
N	3068	3064	3011	3044	3046	2997	3042	3068
adj. R^2	0.190	0.223	0.564	0.624	0.301	0.370	0.441	0.555

Panel B. Balance tests with state fixed effects and log population in 1950

	(1) number of banks per square mile,1950	(2) log deposits per capita, 1950	(3) log median income, 1950	(4) log farm size, 1950	(5) log number of farms, 1950	(6) share of land in irrigation, 1949	(7) value of farm production per acre, 1950	(8) county area
drought exposure	0.000346 (0.000213)	0.0334 (0.0333)	0.00525 (0.0399)	0.133 (0.151)	-0.0550 (0.0857)	-0.000933 (0.00254)	0.0218 (0.0695)	0.0310 (0.0480)
N	3068	3064	3011	3044	3046	2997	3042	3068
adj. R^2	0.264	0.273	0.653	0.717	0.508	0.377	0.575	0.559

Panel C. Balance tests with log population in 1950

	(1) number of banks per square mile,1950	(2) log deposits per capita, 1950	(3) log median income, 1950	(4) log farm size, 1950	(5) log number of farms, 1950	(6) share of land in irrigation, 1949	(7) value of farm production per acre, 1950	(8) county area
drought exposure	0.000287	0.0618	0.0399	0.407*	-0.0234	-0.00421	-0.0342	0.148
	(0.000310)	(0.0435)	(0.0646)	(0.218)	(0.114)	(0.00468)	(0.120)	(0.114)
N	3068	3064	3011	3044	3046	2997	3042	3068
adj. R^2	0.156	0.056	0.099	0.323	0.297	0.001	0.317	0.012

These panels regress a variety of demographic and economic variables—the column headings—(all observed in or pre-1950) on an indicator variable that equals 1 if a county is in the 4th quartile of drought intensity, 1950-1960 using the comprehensive sample of counties. Panel A uses only state fixed effects as controls; Panel B includes both state fixed effects and log population in 1950, and Panel C only controls for log population in 1950. Standard errors (in parentheses) are clustered at the state-level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A1.4 Drought exposure and population growth, 1950-1960- the stratified sample

	(1) all counties	(2) in-sample	(3) quartiles	(4) baseline	(5) WLS	(6) controls I	(7) controls II
drought intensity, 1950-1960, SPI continuous measure	-0.00528**	-0.00773*					
	(0.00235)	(0.00430)					
2nd quartile drought intensity, 1950-1960			-0.0133				
			(0.0256)				
3rd quartile drought intensity, 1950-1960			-0.0368				
			(0.0276)				
4th quartile drought intensity, 1950-1960			-0.0661**	-0.644**	-1.148***	1.231	-0.504
			(0.0317)	(0.292)	(0.339)	(0.881)	(0.409)
log loans per capita, 1950				-0.000127	-0.0290**	-0.00378	0.000407
				(0.00592)	(0.0115)	(0.0038)	(0.00540)
4th quartile drought intensity*loans per capita				0.0260*	0.0414**	0.0169*	0.0223*
				(0.0131)	(0.0166)	(0.0098)	(0.0137)
log population, 1950				0.0748***	0.0121	0.0189	0.0614***
				(0.00991)	(0.0088)	(0.0145)	(0.00951)
4th quartile drought intensity*population				0.0191	0.0759***	0.0483**	0.00496
				(0.0135)	(0.0160)	(0.0211)	(0.0233)
log, area				-0.0127	0.0467**	0.00898	-0.0168
				(0.0184)	(0.0175)	(0.0178)	(0.0198)
4th quartile drought intensity*area				0.0440	0.0125	-0.0166	0.0362
				(0.0280)	(0.0413)	(0.0285)	(0.0251)
N	3082	993	993	991	991	989	977
adj. R^2	0.194	0.205	0.206	0.330	0.381	0.463	0.424

Notes: This table examines the impact of drought exposure on the log change in population in the stratified sample of counties. The dependent variable is the log change in population between 1950-1960. All regressions include state fixed effects, and linearly include the log population in 1950 and log county area in 1950, as well as interacted with the top quartile drought indicator variable. Standard errors in parentheses are clustered at the state level * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. In column 6, the drought indicator (4th quartile drought intensity, 1950-1960) is interacted with deposits per capita, 1950, the mean rainfall in the county; the standard deviation of rainfall; mean snow fall; the standard deviation of snowfall (all based on 20th century averages); the log of county area; the log of median income in the county in 1950; the share of rural population in 1950; and an indicator for whether the county is located west of the 98th latitude. In column 7, the drought indicator variable is interacted with the mean land area in drought, 1985-1926; the Herfindahl-Hirshman Index (HHI) based on male labor occupations in 1950; the HHI based on farm production values in 1950. The first measure is a Herfindahl Hirshman Index (HHI) based on male employment across 13 sectors in the 1950 Census.[20] Intuitively, smaller HHI values mean that employment would be more evenly spread across these 13 sectors, suggesting that the local economy might be more diversified. The second measure of diversification is focused on the agricultural sector itself, and is a HHI based on the market value of 13 types of broad agricultural goods produced in the county in 1950. The 13 market values are: cream and milk;

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[20] The sectors are: professional/technical; farmers (managers); proprietors (managers); clerical; sales; craftsmen; machine operators; household workers; non-domestic service workers; family farm labor; unskilled non-farm labor; and unknown occupations.

live calves; cattle; other dairy products; florist products; forest and horticultural crops; fruit and nut crops; hogs and pigs; nursery and greenhouse products; trees and shrubs; poultry; sheep; vegetable crops. In this case, a smaller HHI would suggest a more diversified local agricultural economy.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A1.5 Correlates of Loans Per Capita, 1950

Panel A. Univariate Regressions

	(1) 4th quartile drought intensity, 1950-1960	(2) log population, 1950	(3) log, area	(4) deposits per capita, 1950, log	(5) median income, 1950, log	(6) rural share of population, 1950	(7) mean rainfall
	0.0556	0.00627	-0.317***	0.763***	0.743***	-0.705***	-0.0286***
	(0.114)	(0.0725)	(0.0975)	(0.111)	(0.216)	(0.228)	(0.00870)
N	993	994	991	992	994	994	991
adj. R^2	0.074	0.073	0.091	0.141	0.093	0.094	0.091

	(8) standard deviation of rainfall	(9) mean snow fall	(10) standard deviation of snow fall	(11) west of 98th meridian	(12) HHI agricultural market value	(13) HHI employment
	-0.000926	0.00463	0.0151	0.310	0.239	-0.961
	(0.0307)	(0.00332)	(0.0105)	(0.277)	(0.477)	(1.098)
N	991	989	989	993	978	993
adj. R^2	0.075	0.077	0.078	0.077	0.075	0.075

Panel A regresses loans per capita (log), 1950 separately on each of the 7 variables named in the columns. Each row reports the coefficient and standard error from these univariate regressions. All regressions include state fixed effects. Standard errors in parentheses and are clustered at the state level * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Panel B. Partial Correlations

	(1) all correlates
4th quartile drought intensity, 1950-1960	0.0256
	(0.0787)
log population, 1950	-0.300^{**}
	(0.112)
log, area	-0.141
	(0.110)
deposits per capita, 1950, log	0.688^{***}
	(0.120)
median income, 1950, log	0.101
	(0.231)
rural share of population, 1950	-1.071^{***}
	(0.284)
mean rainfall	-0.0118
	(0.00961)
standard deviation of rainfall	-0.00638
	(0.0325)
mean snow fall	0.00101
	(0.00666)
standard deviation of snow fall	0.0143
	(0.0195)
west of 98th meridian	-0.0621
	(0.197)
HHI agricultural market value	0.0865
	(0.433)
HHI employment	2.892^{**}
	(1.072)
N	975
adj. R^2	0.157

Panel B regresses loans per capita (log), 1950 jointly on the 13 variables named in the columns. All regressions include state fixed effects. Standard errors in parentheses and are clustered at the state level * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A1.6. Differences at branching-unit banking border

Panel A. Full sample, bank-level outcomes

	Unit	Branching	Total	Test
Number of banks	664 (38.3%)	1,068 (61.7%)	1,732 (100.0%)	
Log assets	15.198 (1.241)	15.330 (1.307)	15.279 (1.283)	0.038
Loans and discounts divided by total assets, 1950	0.273 (0.114)	0.311 (0.137)	0.296 (0.130)	<0.001
Deposits divided by total assets, 1950	0.917 (0.096)	0.900 (0.108)	0.907 (0.104)	0.001
Capital and profits divided by total assets, 1950	0.024 (0.017)	0.027 (0.023)	0.026 (0.021)	0.006

Panel B. Full sample, county-level outcomes

	Unit	Branching	Total	Test
Mean income, log	7.832 (0.256)	7.771 (0.371)	7.793 (0.336)	0.012
Share of rural population	0.621 (0.266)	0.599 (0.267)	0.607 (0.266)	0.250
Population, log	7.969 (1.541)	8.407 (1.704)	8.250 (1.660)	<0.001
Mean farm size	453.188 (1,016.556)	168.172 (224.653)	270.083 (647.923)	<0.001

Panel C. Border sample, bank-level outcomes

	Unit	Branching	Total	Test
Number of banks	515 (44.2%)	650 (55.8%)	1,165 (100.0%)	
Log assets	15.254 (1.282)	15.171 (1.203)	15.208 (1.239)	0.252
Loans and discounts divided by total assets, 1950	0.272 (0.116)	0.313 (0.140)	0.295 (0.131)	<0.001
Deposits divided by total assets, 1950	0.918 (0.086)	0.905 (0.098)	0.911 (0.093)	0.021
Capital and profits divided by total assets, 1950	0.025 (0.024)	0.027 (0.027)	0.026 (0.026)	0.238

Panel D. Border sample, county-level outcomes

	Unit	Branching	Total	Test
Mean income, log	7.813 (0.270)	7.780 (0.361)	7.794 (0.327)	0.250
Share of rural population	0.624 (0.256)	0.638 (0.259)	0.632 (0.257)	0.537
Population, log	7.922 (1.547)	8.133 (1.659)	8.047 (1.616)	0.141
Mean farm size	198.373 (265.933)	177.587 (253.527)	186.058 (258.608)	0.364

This table reports the mean difference in bank (Panels A and C) and county-level outcomes (Panels B and D) across unit and branching banking states in the sample. The "Border samples" restrict the counties to those that are within 200 miles of unit-branching state border—see Figure 4.

Table A1.7 Well Depth, Summary Statistics

	1950-1957		1958-1970		1950-1970
	Drought Exposed	Non-Drought Exposed	Drought Exposed	Non-Drought Exposed	Full Sample
Mean	61.8	58.0	67.9	66.2	64.1
Standard Deviation	69.8	81.9	78.9	96.5	89.5

This table reports summary statistics on well depth from the USGS using the comprehensive sample. Drought exposed are counties with top quartile drought exposure. The source data are available at https://waterservices.usgs.gov/rest/GW-Levels-Service.html.

Table A1.8. The log number of wells in a county

	(1) loans per acre	(2) loans per acre	(3) banks per square mile	(4) banks per square mile	(5) banks per square mile: border
drought exposure	-0.0320 (0.0898)	0.196* (0.112)	-0.190*** (0.0715)	-0.0321 (0.0831)	0.0923 (0.112)
drought#loans per acre, log, 1950	0.0863** (0.0366)	0.0498 (0.0444)			
drought#unit		-0.462*** (0.151)		-0.363*** (0.141)	-0.501*** (0.153)
drought#loans per acre, log, 1950#unit		0.0737 (0.0731)			
drought#banks per square mile, log, 1950			0.173*** (0.0497)	0.156** (0.0642)	0.109 (0.0740)
drought#banks per square mile, log, 1950#unit				0.0676 (0.102)	0.131 (0.105)
R-squared	0.680	0.681	0.682	0.683	0.664
Obs	10315	10315	29627	29627	37549
Fixed effects	county & year	county & year	county & year	county & year	county, border & year
Marginal impact of drought exposure (standard error)					
10th percentile of credit in a **branching state**		0.165 (0.13)		-0.016 (0.08)	0.134 (0.09)
10th percentile of credit in a **unit banking state**		-0.342** (0.14)		-0.372*** (0.11)	-0.315*** (0.09)
90th percentile of credit in a **branching state**		0.422*** (0.16)		0.300*** (0.09)	0.320*** (0.09)
90th percentile of credit in a **unit banking state**		0.293 (0.20)		0.081 (0.09)	0.093 (0.08)

This table studies the impact of drought exposure on the log number of wells in a county-year observation over the period 1950-1970. Drought equals 1 if the county was in the top quartile of drought exposure between 1950 and 1957, and 0 otherwise. Unit equals 1 if a state prohibited branch banking, and 0 otherwise. All regressions include county and year fixed effects. Column 5 also includes border fixed effects. Column 5 restricts the sample to counties no further than 200 miles from a state border that has unit banking on one side of the border and branching on the other side of the state border. Column 5 also includes linearly a county's distance from a state border, as well as a county's distance along a state border using a third order polynomial. Standard errors in parentheses and are clustered at the state level * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A1.9. Differences at the border

Counties up to 200 miles from a state border

	in-state	out-of-state	difference	difference≠0	difference<0 p-value	difference>0
Median income, 1949	2485.02	2457.96	-27.07	0.547	0.726	0.274
Loans per capita, 1950	152.23	159.65	7.42	0.844	0.422	0.578
Deposits per capita, 1950	630.95	600.14	-30.81	0.257	0.872	0.128
Retail stores per capita, 1948	12.45	12.46	0.01	0.968	0.484	0.516
Number of manufacturing establishments per capita, 1940	0.87	0.88	0.00	0.935	0.467	0.533
Mean farm size, 1950	304.83	303.68	-1.15	0.982	0.509	0.491
Annual mean rainfall, 1900-2000	36.63	36.25	-0.38	0.503	0.749	0.251
Log of total population, 1950	10.60	10.41	-0.19	0.011	0.994	0.006
Population growth, 1940-1950	0.07	0.05	-0.02	0.084	0.958	0.042

This table restricts the sample to counties in the sample no further than 200 miles from a state border. For 9 key variables, the table then reports the mean separately for counties on either side of the state border, and tests whether these means are statistically different.

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