Environmental Migration and Race during the Great American Drought, 1935–1940

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Abstract

We study racial differences in internal migration responses to one of the most severe climatic shocks in US history—the drought of the 1930s. Using data from the 1940 census on 65 million adults, we find that individuals exposed to more severe drought between 1935 and 1940 were more likely to make an inter-county move in this period and that this responsiveness was greater for blacks than whites. Blacks' migration premium came despite their systematic disadvantage in the economy of the 1930s and evidence along dimensions other than race that disadvantage limited individuals' ability to adapt to the drought through migration. We argue that these patterns were, in part, the product of the disparate effects of federal relief spending under the Agricultural Adjustment Act (AAA): we find that AAA spending had a greater emigration-inducing effect on blacks than on whites, and that controlling for AAA spending reduces, and in some cases eliminates, blacks' migration premium in response to drought. These results help to illuminate the mechanisms governing the magnitude and composition of migration responses to natural disasters as well as the roles of migration and government policy in disadvantaged groups' responses to natural disasters.

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1 Introduction

As the effects of climate change manifest in the form of more frequent and more severe natural disasters (Banholzer, Kossin, and Donner 2014), understanding whether, to what extent, and under what circumstances individuals respond to such disasters through migration has become an increasingly important goal of the economics of migration (Berlemann and Steinhardt 2017; Black et al. 2013). The effects of natural disasters on the magnitude and composition of migration are theoretically ambiguous and empirical estimates are highly context dependent (e.g., Mahajan and Yang 2020; Spitzer, Tortorici, and Zimran 2022). Nonetheless, a body of research has emerged documenting a series of natural disasters with no effect or a negative effect on migration (e.g., Beine and Parsons 2015; Cattaneo and Peri 2016; Gröschl and Steinwachs 2017; Halliday 2006; Hunter, Murray, and Riosmena 2013; Spitzer, Tortorici, and Zimran 2022; Yang 2008b). Such findings raise concerns regarding *trapped populations* and an *immobility paradox*—a situation in which some individuals want to respond to a climatic shock through migration but for some reason, usually a liquidity constraint that may have been exacerbated by the shock itself,[1] are unable to (e.g., Beine, Noy, and Parsons 2019; Hirvonen 2016; Nawrotzki and DeWaard 2018). Together with evidence that disadvantaged groups may be more affected by climatic shocks (Benevolenza and DeRigne 2019; Capelli, Costantini, and Consoli 2021; Deuchert and Felfe 2015; Sakai et al. 2017), such findings that economic disadvantage might hinder the ability to adjust to environmental shocks through migration suggest that systematically disadvantaged groups might disproportionately bear the burden of environmental shocks. That is, such individuals might both be more likely to be exposed to natural disasters and less likely to be able to move to escape their effects. However, scholarship illuminating differences in migration responses to natural disasters between relatively advantaged and disadvantaged groups is lacking, leaving the extent of this mechanism by which natural disasters might exacerbate inequality poorly understood.

In this paper, we study differences in blacks' and whites' migration responses to one of the most severe climate shocks in US history—the Great American Drought of the 1930s. This drought,

[1] See, for instance Beine and Parsons (2017), Cattaneo and Peri (2016), Gröschl and Steinwachs (2017), Nawrotzki and DeWaard (2018), and Sichko (2022) for evidence that natural disasters generate greater migration responses for better off individuals, households, regions, or countries.

of which the Dust Bowl is the most commonly recognized portion (Cook, Seager, and Smerdon 2014), comprised the worst decade of drought in US history, with the Great Plains in particular experiencing severe or worse drought conditions in every year from 1934–1939 except 1938 (Cook et al. 2010; Seager et al. 2008). Striking in tandem with the Great Depression, the drought was responsible for substantial economic turmoil and hardship (Sichko 2021). The effects of this drought and the related shocks of wind erosion and the Dust Bowl on the quantity and selection of internal migration have been studied in detail (e.g., Gutmann et al. 2016; Hornbeck 2023; Long and Siu 2018; Sichko 2022, 2023). However, differences in the effects of this drought on migration according to race have not been studied. As a result of the substantial racial disparities of the period, a clear understanding of such differences is essential to a study of this context, and, given the continued presence of racial disparities in the modern economy, is an aspect of this setting that can help to illuminate the effects of modern natural disasters.

Our primary data source, and the factor underlying our ability to conduct a detailed study of migration responses to the drought and their differences by race, is the US Census of 1940 (Ruggles et al. 2023). The 1940 census was the first to document internal migration, inquiring about individuals' place of residence 5 years prior in 1935. This enables us to observe the migration decisions of all 65 million adults, both male and female, simply by comparing their places of residence in 1935 and 1940.[2] The 1940 census also provides a wealth of individual-level data, most importantly enabling us to determine individuals' race and their level of education. We combine these data with county-level drought severity measures derived from Cook et al. (2010), as well as data on federal spending on the Agricultural Adjustment Act (AAA) and other New Deal programs by county (Fishback, Horrace, and Kantor 2005, 2006).

We focus first on the difference in migration responses to the drought by race. We find, as has previously been shown by Gutmann et al. (2016) and Sichko (2021), that individuals whose 1935 residence was in a county that experienced a more severe drought from 1935–1939 were more likely to make an inter-county move by 1940. We add to this by showing that the degree to which

[2] These data provide an important advance over other studies of internal migration in US history in that they enable us to observe internal migration without the need to make links between censuses—an approach that is both error-prone and requires the exclusion of women from the analysis (Zimran 2023). The 1940 census, in contrast, enables us to observe all individuals' migration decisions with no error induced by our efforts to process the data.

individuals responded to drought conditions through migration differed by race, and in particular that blacks were more likely to migrate in response to drought than whites. The magnitude of this difference is large: whereas whites experiencing severe drought were about 2.5 percentage points more likely to migrate than otherwise similar whites in the same state experiencing no or mild drought, this difference was 7.6 percentage points for blacks relative to a lower base rate in no- or mild-drought counties. Blacks' greater migration responsiveness to drought is surprising, both in light of the literature on trapped populations and given evidence along other selection dimensions that disadvantage may have hindered individuals' ability to respond to the drought shock through migration. In particular, consistent with Sichko (2022), we find that individuals of either race with 8 or more years of education were at least as likely, and in most cases more likely, than those with fewer than 8 years of education to migrate in response to drought—a result that Sichko (2022) attributes to liquidity constraints inhibiting migration, as envisioned by the trapped populations literature.

We argue that the different migration rates of blacks and whites in response to the drought can be partly attributed to governmental relief policy that had differential impacts by race. Financial inflows to the drought-affected region came from federal spending under the Agricultural Adjustment Act (AAA). This spending was distributed to drought-stricken agricultural communities, but was limited in large part to land owners and required that land be taken out of production as a condition of receipt (Rasmussen 1983). Fishback, Horrace, and Kantor (2006) have shown that spending under the AAA was associated with greater out-migration from targeted counties in the 1930s, which they argue was the product of farmers' incentives to remain and receive payments being outweighed by the underlying incentive to leave and the reductions in labor demand coming from the removal of land from production. Given lower rates of land ownership among blacks than whites in the drought-affected areas, it is plausible that they were less likely to receive relief payments and more likely to have been affected by reductions in agricultural labor demand. For this reason, we hypothesize that the effects of AAA spending on migration may have been stronger for blacks and thus responsible, at least in part, for blacks' greater migration response to drought. In support of this mechanism, we find that the migration-inducing effects of AAA spending were greater for blacks than whites, and that controlling for per-capita AAA spending in a county reduces and sometimes eliminates blacks' premium in migration in response to drought. Notably, the same is not true of other public works spending under the New Deal, which did not discriminate along the lines of land ownership; that is, our results regarding the black-white differences in migration responses are robust to controlling for such spending. We also find that greater levels of home ownership in 1930 by county and race, which we view as a county-level proxy for access to AAA funds, moderated the migration-inducing effects of AAA spending and did so to a greater extent among blacks than whites.

This paper contributes to the literature on US internal migration in modern (Jia et al. 2023; Molloy, Smith, and Wozniak 2011) and historical (Ferrie 2006; Rosenbloom and Sundstrom 2004; Zimran 2023) contexts, and in particular to the portion of this literature focusing on migration by blacks in the early twentieth century (e.g., Boustan 2017; Collins and Wanamaker 2015). It also adds to the literature on the effects of the drought and Dust Bowl of the 1930s (e.g., Arthi 2018; Hornbeck 2012), on the broader economic situation of the 1930s (Fishback 2017), and on the intersection of these shocks with migration (e.g., Fishback, Horrace, and Kantor 2006; Gutmann et al. 2016; Hornbeck 2023; Long and Siu 2018; Sichko 2022, 2023).[3] These literatures have developed a detailed understanding of migration patterns in the 1930s for the population as a whole and dividing by race of exposure to natural disasters. But the intersection of these—the differential migration responses to the 1930s drought along the dimension of race—is not well understood and is our contribution to these literatures.

This paper also contributes to the economics of migration in response to natural disasters. First, this paper contributes to the literature on migrant selection in response to natural disasters and climate shocks. Difficulties in accessing individual-level data have hampered this literature (e.g., Beine and Parsons 2017; Cattaneo and Peri 2016; Gröschl and Steinwachs 2017; Nawrotzki and

[3] Related research focuses on dust storms and soil erosion (Hornbeck 2012, 2023; Long and Siu 2018). Dust storms, soil erosion, and drought were related but distinct environmental disasters. Dust storms and soil erosion were caused by farming practices unique to the 1930s U.S. and drought (Hansen and Libecap 2004). Therefore, studying dust storms and soil erosion is, in part, studying the impact of an environmental shock and, in part, farming practices. Drought was the underlying environmental shock that contributed to dust storms and soil erosion, and droughts remain among the most common and destructive environmental shocks, while the farming practices that contributed to 1930s dust storms and erosion changed starting in the late 1930s. The study of the drought is also more appropriate to the time horizon that we cover—soil erosion constituted a long-term shock to the attractiveness of a location (Hornbeck 2023), but the 1940 census data only enable us to observe short-term effects, and so we focus on the more immediate—though still substantial—shock

DeWaard 2018; Spitzer, Tortorici, and Zimran 2022; c.f., Gutmann et al. 2016; Hornbeck 2023; Sedova and Kalkuhl 2020; Sichko 2022, 2023), forcing researchers in many cases to use aggregate-level data that make results susceptible to the ecological fallacy. Moreover, much of the recent literature on disaster migration is situated in the modern migration environment in which selective and restrictive policy can artificially alter the composition of flows of disaster migrants. Our setting of internal migration and individual-level data obviate these concerns. Indeed, the intersection of a shock of historic proportions with a uniquely detailed dataset provides a unique setting to study. To our knowledge, selection in the sense of the differential responses of disadvantaged minority groups, which is our focus, has not been studied either in this context or more broadly.[4]

In addition to helping to expand this limited literature, our results make several interesting contributions in this regard. First, we show that, even in a situation in which one dimension of selection (education) shows evidence of positive selection, it need not be the case that disadvantaged minority groups are less likely to migrate. This finding has important implications for understanding the extent to which such groups may be subject to concerns over trapped populations. We also show that migration may be a different adjustment for minorities than for more advantaged groups, as they may migrate not only to avoid the shock but also in response to governmental reactions that make remaining home less tenable. Indeed, we find that government policy is an important determinant of how minority groups react to environmental shocks, thus adding to a growing body of literature documents the consequences of government spending, laws, and regulations that are ostensibly race-neutral but nonetheless have implications for racial inequality (Muhammad, Sichko, and Olsson 2023).

Our second contribution to the disaster migration literature is to illuminate mechanisms by which natural disasters may affect migration. Financial (Bettin and Zazzaro 2018; David 2011; Mohapatra, Joseph, and Ratha 2009; Yang 2008b), and especially governmental relief (Paul 2005), inflows have been shown to follow natural disasters and to impact migration responses to them. Attachment to land has also been posited as a factor limiting migration responses to natural disasters (Spitzer,

[4]Mastrorillo et al. (2016) study racial differences in migration responses to climate variability in South Africa, but in that context the disadvantage group is the majority, not the minority. Nonetheless, the results are likely informative for our case.

Tortorici, and Zimran 2022). Our findings regarding the role of AAA spending and land ownership illustrate how these factors can intersect to shape migration responses to natural disasters and show how the particular structure and targeting of relief spending can determine its effects on migration as an adjustment mechanism.

2 Background

2.1 Migration responses to natural disasters

A simple push-pull view of migration views natural disasters as reducing the utility of remaining in the affected area—for instance by reducing incomes or destroying capital in the affected area—thus increasing individuals' incentives for and probability of emigration.[5] In practice, however, several forces have been shown to dampen or even reverse such a positive effect of disasters on migration.[6] The most commonly cited such mechanism is that natural disasters might exacerbate liquidity constraints, thus reducing individuals' ability to finance migration.[7] Migration in response to natural disasters has also been shown to potentially be hindered by agricultural institutions that bind individuals to the land. For instance, Spitzer, Tortorici, and Zimran (2022) show that agricultural relationships such as ownership, tenancy, and sharecropping, as opposed to unattached day laboring, were associated with reduced responsiveness to an earthquake shock.

Mechanisms such as these have been hypothesized as explanations for cases in which natural disasters are not followed by migration responses—a confluence of circumstances that has led some researchers to speculate that, in some cases, poor and otherwise disadvantaged populations would want to respond to disasters by leaving the affected area but are unable to do so. These so-called

[5]On the effects of natural disasters on incomes see, for instance, Baez and Santos (2008), Banerjee (2007), Cai et al. (2016), Caruso (2017), Gröger and Zylberberg (2016), and Spitzer, Tortorici, and Zimran (2022). For examples of natural disasters increasing migration probabilities, see, for instance Bohra-Mishra, Oppenheimer, and Hsiang (2014), Dallmann and Millock (2017), Dillon, Mueller, and Salau (2011), Drabo and Mbaye (2014), Gray and Mueller (2012), Gröger and Zylberberg (2016), Gutmann et al. (2016), Hornbeck (2012), Karadja and Prawitz (2019), Mahajan and Yang (2020), Mastrorillo et al. (2016), Mueller, Gray, and Kosec (2014), Murathanoğlu (2023), Reuveny and Moore (2009), and Thiede, Gray, and Mueller (2016).

[6]See, for instance, Beine and Parsons (2015), Cattaneo and Peri (2016), Gignoux and Menéndez (2016), Gröschl and Steinwachs (2017), Halliday (2006), Hunter, Murray, and Riosmena (2013), Paul (2005), Penning-Rowsell, Sultana, and Thompson (2013), Spitzer, Tortorici, and Zimran (2022), and Yang (2008b).

[7]See, for instance, Beine and Parsons (2017), Cattaneo and Peri (2016), Gröschl and Steinwachs (2017), Hirvonen (2016), Nawrotzki and DeWaard (2018), and Sichko (2022).

trapped populations, already disadvantaged, may have their disadvantage compounded by being even more strongly affected by disasters (Beine, Noy, and Parsons 2019; Nawrotzki and DeWaard 2018).

Other mechanisms, however, might hinder migration responses to natural disasters by counteracting the greater incentive to move generated by the shock rather than by preventing individuals from moving. For instance, the destruction wrought by a disaster may lead to growth in demand for reconstruction labor after the shock, potentially raising local wages and reducing the gains to migration (Kirchberger 2017). A similar mechanism can be faced within the household rather than through the market—in the wake of the disaster, the marginal product of labor invested in reconstruction at home may increase, also reducing incentives for emigration (Halliday 2006). Migration might also be reduced in response to financial inflows to affected regions, which might come in the form of private or public reconstruction aid, remittances by prior migrants, or governmental relief (Bettin and Zazzaro 2018; David 2011; Mohapatra, Joseph, and Ratha 2009; Murathanoğlu 2023; Paul 2005; Yang 2008a). Such inflows can reduce the impact of the shock, eliminating or reducing the incentive to leave.

The same mechanisms determining the magnitude of the migration response to natural disasters also shape the composition of any such flows. For instance, liquidity constraints have been shown to induce positive selection into migration (e.g., Angelucci 2015; Belot and Hatton 2012; Chiquiar and Hanson 2005; McKenzie and Rapoport 2010; Orrenius and Zavodny 2005; Spitzer and Zimran 2018). If such constraints are exacerbated by a disaster, they might also drive positive selection into migration in response to natural disasters. Little is known, however, regarding the nature of selection into disaster-driven migration. Moreover, much of what is known is based on heterogeneity in migration responses in aggregate data—for instance, a greater migration response among better-off regions or countries is interpreted as evidence of liquidity constraints impeding migration (e.g., Nawrotzki and DeWaard 2018). Such results are, of course, subject to the ecological fallacy, but are necessary given the limited availability of individual-level data with which to study the impacts of natural disasters on the composition of migratory flows. Where such data are available (e.g., Sedova and Kalkuhl 2020; Sichko 2022), estimates of migrant selection are context dependent, and generally focus on either wealth or agricultural status.

Two issues in the literature on the response of the magnitude and composition of natural disasters to migration help to illuminate the contribution of this paper. The first is the limited understanding of selection into disaster migration. Within this already limited literature, the differences between the response of majority and disadvantaged minority groups to natural disasters remains poorly understood (c.f., Mastrorillo et al. 2016). Our study brings these differences into sharper focus. The response of minority groups is particularly important to understand in light of concerns over trapped populations. Insofar as such populations are the product of economic disadvantage, the concern arises that disadvantaged minority groups might be more likely to be constrained in their migration, and thus might be less able to migrate to avoid the impacts of natural disasters.

Our unique setting of a substantial shock intersecting with complete-count individual-level data enables us to illuminate this aspect of the migration effects of natural disasters. Our focus on a setting of internal migration also sidesteps concerns that many existing studies' findings of the existence of trapped populations derive from modern settings in which substantial legal obstacles to migration might artificially limit the ability of some groups to migrate more than others.

The second issue underlying our contribution is that, although a number of potential mechanisms for the migration effects of natural disasters have been posited, the fact that each natural disaster is unique implies that a myriad of cases must be studied in order to better understand when and under what circumstances each mechanism applies. We add another case to this body of evidence, highlighting the roles of attachment to land and of government relief spending in shaping the composition of migration rather than simply its magnitude. We also show how these mechanisms can differ in their impacts across majority and minority groups.

2.2 Race, migration, and drought in the 1930s United States

The Dust Bowl is one of the most severe and well-known natural disasters in US history. What is not widely recognized, however, is that the Dust Bowl was only a small (though important) part of a natural disaster that was much broader in time and space—the drought of the 1930s, which marked the most severe 10-year drought in U.S. history (Heim 2017; Sichko 2021). Starting in 1930 in the southeast, the drought persisted with varying intensity across the country until 1939. The year 1934, distinguished as the worst drought year in the last millennium, marked a turning point, elevating the drought to levels unmatched by previous or subsequent droughts (Cook, Seager, and Smerdon 2014; Cook et al. 2007). From 1934 onward, the Great Plains, particularly the northern Plains, bore the brunt of the drought. Notably, 1938 stands out as the sole year without a significant portion of the Plains experiencing severe or worse drought conditions from 1934 to 1939. Despite the severity, extensive reach, and prolonged duration of the drought, research on its economic impact is remarkably scarce, partly because of the fact that detailed geographic data on drought severity only became available in the last few decades.

There is a substantial body of research studying migration in response to this drought, though the disaster is operationalized in several different ways in this literature. The largest set of studies focuses on the Dust Bowl itself—either the core 20 southern Great Plains counties identified by the US Department of Agriculture's Soil Conservation Service (Joel 1937) as having been most affected by wind erosion and dust storms in the 1930s, or a broader set of about 100 counties in the same area (e.g., Gregory 1991; Hurt 1981; Long and Siu 2018; Riney-Kehrberg 1994; Worster 1979 [2004]). Hornbeck (2012, 2023) instead focuses on erosion in a broader set of Great Plains counties. Finally, as we do, Gutmann et al. (2016) and Sichko (2021, 2022, 2023) focus on the drought itself. This focus benefits from the fact that soil erosion was the product of a combination of drought and farming practices, where the latter may have been endogenous to local characteristics.

The bulk of this literature focuses on the magnitude of the response of migration or of net population flows (e.g., Gutmann et al. 2016; Hornbeck 2012; Long and Siu 2018), finding evidence of outflows from the Great Plains and a decline of in-migration to the core Dust Bowl area. Studies of selection into migration in this context are rarer (Hornbeck 2023; Long and Siu 2018; Sichko 2022). Sichko (2022) finds that the probability of migration from drought was increasing in education. Hornbeck (2023) finds that the average migrant from wind-eroded places was negatively selected in terms of education. Long and Siu (2018) find neutral selection for migrants from the core Dust Bowl on either unobservables or a broad set of observables.

What is lacking in the literature on migration and the 1930s drought is an understanding of the role of race. Prior research has included individuals of all races, but due to fact that the drought-affected areas were overwhelmingly white, the fact that this prior research has not studied differences in responses across races essentially entails a focus on the white population. This paper aims to shift the focus and to understand the extent to which a disadvantaged minority—blacks—were able to follow the bulk of the population and use migration as an adjustment mechanism in the face of drought.

One of the main governmental responses to the drought and Dust Bowl came in the form of the Agricultural Adjustment Act (AAA). AAA spending, which eventually totaled over \$1.9 billion, or over 12 percent of all New Deal grants (Fishback, Kantor, and Wallis 2003), was intended to aid the drought-stricken agricultural communities of the Great Plains, with the highest proportion of money targeted at the Dust Bowl.[8] In addition to providing relief payments to farmers, a goal of AAA spending was to raise agricultural prices by reducing surpluses, with goal reductions of 25 to 50 percent for targeted crops (Howlader 2023). To this end, payments were targeted to landowners and were conditional on the removal of land from production. While such payments would have reduced land-owning farmers' incentives to emigrate, others would not only have had to endure drought without aid, but would also have suffered from the reduction in labor demand due to land being removed from production. Fishback, Horrace, and Kantor (2006) find that AAA payments were associated with greater outmigration, indicating that the latter effect outweighed the former. This pattern differed from the effects of other New Deal public works spending, which was broadly targeted and attracted in-migration. The AAA also had effects beyond migration. In the South, where the bulk of the black population lived, it has been shown that the AAA had racially disparate effects as a result of different exposure to institutions such as share tenancy and sharecropping by race, with a greater reduction in tenancy and sharecropping among blacks than whites (Biles 1994; Depew, Fishback, and Rhode 2013).

The unique broader context of the 1930s also contributes to shaping the environment that we study. Most importantly, the drought came in the midst of the Great Depression. As is typically the case during economic downturns (e.g., Molloy, Smith, and Wozniak 2011; Saks and Wozniak 2011),

[8] See also Figure 6.

internal migration rates in the 1930s had fallen substantially relative to their prior levels (Zimran 2023), though there were population flows away from areas particularly hard-hit by the downturn (Boustan, Fishback, and Kantor 2010). This was true for whites, for whom internal migration rates had previously been largely stable. It was also true for blacks, for whom the 1930s marked a pause in the Great Migration—an acceleration of internal migration that began around 1910 and would stretch to about 1970 (Collins 1997; Collins and Wanamaker 2015; Derenoncourt 2022). Despite this ongoing migration, most blacks still lived in the South in 1935.[9] The South was characterized by widespread discrimination, including segregated schools that received less funding, resources, and opportunities compared to white schools (e.g., Baker 2016). Black communities, already vulnerable and facing poverty, were particularly affected by the Great Depression, with high unemployment rates and a disproportionate impact due to discriminatory employment practices (e.g., Sundstrom 1992).

3 Data

3.1 Sources and construction

Our main data source is the 1940 US census (Ruggles et al. 2023), which provides extensive demographic information, such as age, race, gender, and education, for each person in the United States at this time, including 65 million adults aged 23–70 (i.e., aged 18–65 in 1935), who constitute our sample of interest. Most important for our purposes is that the census inquired not only about information at the time of the census, but also on each individual's place of residence 5 years earlier, marking an important change relative to earlier censuses. Prior to this point, the only ways to study internal migration in the United States are to either use information on individuals' place of birth—which is informative only of the lifetime inter-state migration of natives—or to use linked census data (Zimran 2023), which are prone to error (Abramitzky et al. 2021; Bailey et al.

[9] In 1930, the black population remained predominantly concentrated in the South, as depicted in Figure 2. While the drought of the late 1930s primarily impacted regions with a lower black population, there was also drought in the early 1930s that severely affected much of the South, with over half of the black population experiencing two or more drought years during this period. To our knowledge, no research has specifically examined the impact of drought on blacks in the 1930s. Although beyond the scope of this paper, this is an area that merits further investigation.

2020), omit large fractions of the population, and are systematically unable to offer insights into the behavior of women. For the period 1935–1940, on the other hand, an individual's migration status is directly reported, enabling us to observe the inter-county migration of all adults over a known period of time with no error or exclusion coming from our efforts to process the data. The 1940 census also reports whether an individual's 1935 place of residence was on a farm.

The main drawback of the use of the 1940 census is that we are limited in the extent of pre-migration data that we can observe. While the 1940 census reports socioeconomic information of interest such as occupation and income, these are all observed in 1940, after any migration had taken place, making this information endogenous to the migration decision that we are interested in. However, by focusing on race, age, and gender, we can be sure that the characteristics that we observe are pre-determined. We also use the education data despite the fact that they were collected in 1940, relying on our focus on individuals at least 18 years old in 1935 to reduce the likelihood that individuals would have accrued additional education in the 1935–1940 period.

Our drought data come from the US National Atmospheric and Oceanic Administration, which offers historical drought data through the Living Blended Drought Atlas (LBDA) (Cook et al. 2010). The LBDA is an updated version of the Palmer Drought Severity Index (Palmer 1965), which is widely used for measuring variations in drought severity across time and space. The LBDA data used in this study estimate yearly drought conditions based on meteorological factors and provide information on drought severity relative to the calibration period of 1928 to 1978; that is, the LBDA does not simply describe areas as particularly wet or dry, but captures deviations from the norm in each location. The continuous scale has cutoff values for specific levels of drought; for example, cutoffs of -4 and 4 denote extremely dry and wet conditions, respectively, relative to the local average.

The drought data provided by Cook et al. (2010) are annual and for specific points in the United States. Our data, however, are based on individuals' counties of residence in 1935 and 1940. We determine a county's annual drought severity according to a spatial interpolation method described by Sichko (2021). We then aggregate each county's drought exposure over the period 1935–1939—that is, from when we first observe individuals' places of residence until the year before we observe whether they had moved—and assign to each individual the drought exposure of their 1935 county of residence. We use 1939 as the last year in computing our drought measure because the census was enumerated in April of 1940. In particular, we define the total drought exposure of county c, D_c, as

$$D_c = \sum_{t=1935}^{1939} \mathbb{1}\{d_{ct} < 0\} \times |d_{ct}|, \tag{1}$$

where d_{ct} is the drought severity of county c in year t. Thus, our drought measure in expression (1) is the sum of the absolute values of the drought index in years in which a county experienced below-normal soil moisture. We then divide counties into three groups on the basis of their value of D_c: counties with $D_c < 5$ are categorized as experiencing no or mild drought over the period 1935–1939; counties with $D_c \in [5, 8)$ are defined as experiencing moderate drought; counties with $D_c \geq 8$ are defined as having experienced severe drought. Thus, the lower limit for the moderate drought category corresponds to having experienced a mild drought in each of the five years of the period;[10] this is also the mean of the measure across all counties. The cutoff between the moderate and severe drought measure is set at one standard deviation above the mean (rounded to the nearest integer). We show below that our results are robust to alternate definitions of drought exposure.

A limitation of the combination of census and drought data is that the precise timing of individuals' migration is unobserved; individuals who migrated over the period 1935 to 1940 might have done so at any point in this span, meaning that the drought exposure of their 1935 county of residence over the 1935–1939 period may not capture each individual's true drought exposure. For this to be a concern (i.e., for our results to be spurious), it would have to be the case that individuals systematically migrated away from drought counties for reasons other than drought before they experienced a drought.

Our study of the effects of AAA spending is based on data on spending on the AAA and other New Deal programs by county, provided by Fishback, Horrace, and Kantor (2005, 2006), which also provide data on Great Depression severity. We supplement these data with information on homeownership from the 1930 US census (Ruggles et al. 2023). Finally, for use as controls in our

[10] Equivalently, the minimum cutoff could be met by one year of extreme drought (-4) and one year of mild drought (-1).

analysis, we collect data on soil erosion (Hornbeck 2012).

3.2 Summary statistics

Figure 1 describes our main explanatory variable—the drought severity experienced by each county over the period 1935–1939, computed according to equation (1). The area under severe drought, indicated in dark red, covers the Great Plains, and particularly the northern Great Plains: in the north, the severe-drought area stretches from Minnesota to eastern Washington and Oregon, and in the south it covers western Kansas, Nebraska, and Oklahoma. The moderate drought region largely expands the periphery of the severe drought area, incorporating areas such as northern Wisconsin, northern Utah, eastern Oklahoma and northern Texas. There were also a group of counties in moderate drought in New York, stretching along an east-west axis from Buffalo to New York City.[11]

Figure 1 also indicates the broadest region typically considered to have been part of the Dust Bowl according to the US Department of Agriculture (Natural Resources Conservation Service 2012). It is immediately apparent that our treatment differs from the traditional Dust Bowl. The area under drought is substantially larger than the traditional Dust Bowl region, which includes counties experiencing all levels of drought according to our definition. As discussed above, our instrument also differs geographically from Hornbeck's (2012, 2023) focus on soil erosion. The area with the worst soil erosion on the Plains (southeast Nebraska, Kansas, and Oklahoma) is both south and east of the worst area of drought.

Figure 2 presents the 1935 distribution of population. Panels (a) and (b) show the complete distribution of the adult white and black populations, respectively, with darker colors indicating a greater share of total population. As expected, the white population is broadly distributed east of the 100th meridian, but is most concentrated in counties in the northeast and on the west coast. The black population is largely concentrated in the south, but, reflecting the first phase of the Great Migration (Collins and Wanamaker 2015), also shows concentration in northern cities. Panels (c) and (d) repeat panels (a) and (b), respectively, but limit attention to individuals living in counties

[11] Our robustness checks changing the cutoffs for the definitions of moderate and severe drought have the additional benefit of removing the New York counties from the drought group, thus ensuring that our results are not driven solely by the geographically small but populous eastern drought area.

that experienced severe or moderate drought according to our definition above. These panels serve to highlight where the treated population of each race lived. On the whole, about 29.0 percent of the white population and about 11.6 percent of the black population lived in a moderate or severe drought county, as shown also in Table 1, which also presents summary statistics for other variables by 1935 county drought exposure. The distribution of the treated white population roughly matches the geography of the treated area as presented in Figure 1. For blacks, however, much of the drought area shows a negligible black population, consistent with the Great Plains being almost completely white. Instead, the bulk of the black population in the drought area lived either in New York State or in eastern Oklahoma and northern Texas. Given the very different geographic distributions of the black and white treated populations, caution will be necessary in our analysis in making comparisons between the responses of blacks and whites to drought.

Figure 3 presents basic statistics on our main outcome variable—the probability of making an inter-county move between 1935 and 1940. Panel (a) presents these probabilities divided by race, showing that about 13 percent of whites and 8 percent of blacks made an inter-county move over this period. Panel (b) divides each race by drought category. For both races, the migration probabilities for individuals in no- or mild-drought counties and individuals in moderate-drought counties were very similar, with a slight migration premium associated with drought for whites and a slight penalty for blacks. For both races, however, a clear migration premium is evident for individuals in severe drought counties. These differences, however, do not account for potential underlying differences between drought and non-drought areas. One telling statistic is that people in drought counties were more likely to be living outside of their state of birth than those in non-drought counties, as shown in Table 1. For example, 53 percent of whites in drought counties were in their birth state, while it was 65 percent in non-drought counties. For blacks, these figures were 41 and 68 percent, respectively. These differences suggest another consideration to be taken into account in our empirical strategy.

Figure 4 presents education distributions by race, drought status, and migration status. Panels (a) and (b) focus on race, drought status, and education. The systematic disadvantage of blacks in this period in terms of education (e.g., Baker 2016) is readily apparent, with the plurality of whites having 8–11 years of education and the majority of blacks with fewer than 8 years of education. Whereas the white education distribution is similar across drought and non-drought regions, blacks in drought counties were somewhat more educated than blacks in non-drought counties likely reflecting the exclusion of the South and its particularly low levels of black education from the drought region. Panel (c) presents migration probabilities by education status. Both races display a clear education gradient in migration, with more educated individuals more likely to have moved, and the gradient substantially stronger for whites than blacks.

Given our focus on relief policies directed to landowners as a mechanism for our findings, and because of Spitzer, Tortorici, and Zimran's (2022) findings that attachment to land can impede migration responses to natural disasters, the likelihood that individuals were homeowners is important to understanding migration responses to drought and their differences across race. Figure 5 presents information on homeownership by race and drought status in 1940. Because these data are from 1940—after any migration of interest had taken place—we consider the information in Figure 5 to be suggestive of potential patterns of interest, but do not give these figures an interpretation beyond this. There is a clear homeownership premium for whites in both drought and non-drought counties, as is to be expected (Collins and Margo 2011), with a somewhat larger premium, as well as higher rates overall, in non-drought counties than drought counties. These patterns make plausible a potential ownership-based explanation for racial differences, though our ability to test such explanations is limited by a lack of individual-level 1935 ownership data.

Ownership was especially important because AAA spending was directed to farm owners rather than laborers, tenants, or sharecroppers (Fishback, Horrace, and Kantor 2006). Panel (a) of Figure 6 presents the geographic distribution of AAA spending per capita. A clear relationship between AAA spending and the extent of drought is evident from this map, as is a clear focus of AAA spending in the traditional Dust Bowl area of northern Texas, western Oklahoma, and western Kansas. There was also substantial AAA spending outside of these regions, however, with a concentration of spending in the South. In total the correlation between a county's D_c as defined in equation (1) and per-capita AAA spending was 0.55. Other New Deal spending, the distribution of which is depicted in panel (b) of Figure 6, does not show such a strong relationship with the severity of drought, with a correlation of about 0.11.

4 Empirical strategy

Our main estimating equation is

$$M_{ic} = \alpha + \beta_1(\text{moderate drought})_c + \beta_2(\text{severe drought})_c \\ + \theta_1 X_{i1935} + \theta_2 X_{c1935} + \gamma_{s1935} + \gamma_a + \epsilon_{ic}. \quad (2)$$

In this equation, M_{ic} is an indicator taking a value of one if individual i living in county c in 1935 made an inter-county move between 1935 and 1940; X_{i1935} is a vector of individual-level controls in 1935, including the number of children and indicator variables for whether the person was male, white, foreign born, in a city, and in their birth state;[12] X_{c1935} is a vector of controls at the level of the 1935 county of residence, including average age, fraction male, fraction white, fraction in a city, fraction in their birth state, average education in years, fraction foreign born, population, number of moderate or worse drought years from 1930 to 1934, and log change in per capita retail sales from 1929 to 1933 as a measure of Great Depression severity; γ_{s1935} are fixed effects for the 1935 state of residence to ensure that results are not driven by geographic differences in population distributions; and γ_a are age fixed effects. We cluster standard errors at the level of the 1935 state. With the treatment at the county level, such clustering has the effect of both ensuring that standard errors are clustered at at least the level of treatment, and of capturing in a simple way the potential for spatial correlation in errors.

The coefficients of interest are β_1 and β_2, which can be interpreted as the percentage-point migration premium for individuals living in counties of moderate or severe drought, respectively, as compared to individuals living in counties experiencing no or mild drought.[13] In our main analysis, we estimate equation (2) separately for each race. In order to test for the statistical significance of differences of the estimates between races, we also estimate a form of equation (2) in which we

[12] The indicator for being in one's birth state is intended to capture individuals' migration propensities.

[13] We also present robustness checks in which we estimate logit regressions of the same form instead of linear probability models in order to capture proportional differences in migration probability rather than level differences.

include both blacks and whites and interact all variables with a race indicator. Identification in equation (2) derives from comparing the migration probabilities of observationally similar individuals in observationally similar counties within the same state that experienced different levels of drought. In order to study heterogeneity in the migration response to drought across individuals or counties of different characteristics, we also adjust equation (2) by interacting the drought severity indicators with the heterogeneity dimension of interest. By limiting the comparison to observationally similar individuals and counties within the same state, including controlling for urban status and previous history of migration (as captured by a mismatch between birth state and state of residence), we aim to control for the possibility that drought counties and their residents were inherently different from non-drought counties and their residents, which, despite the random nature of the drought, is possible as a result of the naturally geographically clustered nature of the treatment.[14]

5 Results

Figure 7 presents our main results—estimates of equation (2) by race.[15] These results are indicative of a migration response to drought for both blacks and whites that was stronger for more severe droughts. For whites, individuals experiencing moderate drought were 1.1 percentage points more likely to migrate than individuals experiencing no or mild drought, though the difference is not statistically significant; individuals experiencing severe drought were 2.5 percentage points more likely to migrate than were individuals in non-drought or mild-drought counties, and the difference is statistically significant. The estimates are substantially larger for blacks: individuals in moderate-drought counties were 2.7 percentage points more likely to migrate than individuals in non-drought or mild-drought counties, and those in severe-drought counties were 7.6 percentage points more likely. Both of these estimates are statistically significant. This increase in migration propensity constituted a near doubling of migration rates for blacks, whose average 5-year migration rate in no-

[14]Our measure of selection differs from that of Hornbeck (2023), who estimates an equation similar to our interaction version of equation (2). However, Hornbeck's (2023) estimation differs in that education is his outcome variable, and erosion, migration, and the interaction of erosion and migration are the explanatory variables. In practice, this means that Hornbeck estimates the difference between the average migrant and stayer from erosion rather than migration probability as we do.

[15]Online Appendix Table A.1 presents these estimates in tabular form.

or mild-drought counties was 8.7 percent.[16] Notably, the differences between the drought coefficients for blacks and whites are statistically significant (see panel b of Online Appendix Figure A.2). Thus the results of Figure (2) provide the following three results. First, consistent with a number of other studies of our setting (Gutmann et al. 2016; Sichko 2021, 2022), individuals responded to drought in the 1930s by migrating. Second, this response occurred not only for whites, as previous research has established, but also for blacks. Finally, our results imply that blacks were more responsive to drought than whites, in the sense that the increase in migration probability for those who experienced drought relative to those who did not was larger.

Our results in general, and in particular the racial differences that we document, are not the spurious consequence of our drought definition. In panel (a) of Online Appendix Figure A.1, we show that the results are robust to changing the thresholds of the drought category definitions, namely changing the cutoff between mild and moderate drought from 5 to 6 and that between moderate and severe drought from 8 to 11, which has the effect of removing the New York counties from the moderate drought category. Our results are also not the spurious result of our choice to use a linear probability model. Panel (a) of Online Appendix Figure A.2 show that they are robust to using a logit model instead, in which the base migration probabilities are taken into account rather than simply the percentage point change in migration probability.

These results are surprising in light of the concerns in the disaster and environmental migration literatures regarding trapped populations. They are also surprising in light of findings by Sichko (2021, 2022) that migration in response to the 1930s drought was positively selected on the basis of education—a result that he attributes to liquidity constraints hampering potential migration responses, as feared by scholars documenting trapped populations. Given the substantial economic disadvantage of blacks in the economy of the 1930s, it would be natural to expect that their migration responses to drought would be similarly constrained. The results of Figure 8 reinforce this surprise.[17] In this figure, we repeat the estimation of equation (2), again separately by race, but this time we interact the drought category indicators with education category indicators, enabling us to divide

[16]Notably, the base migration rate of whites in no- or mild-drought counties was higher, rendering their drought responses even smaller in comparison.

[17]These results in table form are presented in Online Appendix Table A.2. Robustness to the alternate definition of drought is demonstrated in panel (b) of Online Appendix Figure A.1.

the migration responses to drought by education as well as race. For whites, the drought category indicators are very close to zero and not statistically significant, indicating no migration response to drought by whites with less than 8 years of education. This is also true for whites with 8–11 years of education who experienced moderate drought. For whites with middle education experiencing severe drought, a migration response begins to become evident, as it is for individuals with higher education for both moderate and severe drought.

For blacks, however, the coefficients on the drought level indicators are positive, large, and statistically significantly greater than zero, indicating a migration response to drought by individuals at all levels of education. The interaction terms with education are close to zero and not statistically significantly different from zero, other than that for the highest level of education interacted with severe drought, indicating a greater migration response in this case. These results are striking—despite the education gradient for whites, indicating positive selection into a migration response to drought in terms of disadvantage, the migration response for blacks was not only greater than that for whites, but encompassed individuals of all levels of education. Thus, even in a situation in which disadvantage by one measure (education) limited migration, disadvantage along another dimension (race) promoted it. The migration response to natural disaster in this case is thus more complex than it would appear to be when studying a single dimension of selection.

6 AAA spending and migration responses to drought

The main governmental response to the economic harm wrought by the drought came in the form of spending under the AAA. Under this program, relief payments were made to landowners, who were in turn required to take land out of production, ultimately generating out migration (Fishback, Horrace, and Kantor 2006).[18] We add to these results by studying differential effects of AAA spending on the migration response to drought by race. We hypothesize that because blacks were less likely to access AAA funds, the aggregate incentive to emigrate that this spending created would have been stronger for them.

[18] See also Alston (1981), who argues that AAA payments incentivized mechanization, which would have further reduced agricultural labor demand.

Figure 9 tests to what extent our results can be explained by AAA spending.[19] Panel (a) of this figure repeats Figure 7, but controls for a county's per-capita level of AAA spending. Strikingly, simply adding this control substantially alters our findings.[20] Whereas, in Figure 7, we find substantial drought responses for whites experiencing severe drought and for blacks experiencing either moderate or severe drought, we no longer find this. While we continue to find positive and statistically significant coefficients for whites experiencing severe drought and blacks experiencing moderate drought, these coefficients are substantially smaller when controlling for AAA spending. Moreover, the large coefficient for blacks experiencing severe drought is completely eliminated when adding the AAA spending control. The AAA coefficients are also positive and statistically significant, and are particularly large for blacks, for whom an additional $100 of AAA spending per capita was associated with a 2.5-percentage-point increase in migration probability. These results suggest that it was not drought per se, or at least not entirely drought, that drove emigration, but the governmental relief inflows that followed. Notably, the same results do not hold when we replace per-capita AAA spending with per-capita spending on other New Deal public works projects, which were not directed to landowners and did not require the removal of land from agricultural production. As shown in Online Appendix Figure A.4, controlling for per-capita public works spending does not meaningfully change the coefficients on the drought category indicators, nor is there a relationship between public works spending and migration probabilities for either race.[21]

These results provide important insights to the literature on migration responses to natural disasters. In other contexts (e.g., Paul 2005), it has been argued that increases in governmental aid inflows (as well as remittances from prior migrants), which increased in response to natural disasters,[22] offset the incentive to leave disaster-affected areas. The case of AAA spending and the 1930s drought in the United States offer another perspective on the potential role of relief spending in determining emigration responses to natural disasters—as a result of the peculiar structure of the

[19]The estimates are presented in tabular form in Online Appendix Table A.3. Panels (c) and (d) of Online Appendix Figure A.1 verify robustness to the alternate drought category cutoffs.

[20]Online Appendix Figure A.3 tests for statistical significance of the differences between the black and white coefficients in panel (a) of Figure 9 by combining the two sets of estimates into a single interaction equation.

[21]These results are consistent with Fishback, Horrace, and Kantor's (2006) findings that public works spending in a county encouraged *in*-migration. Their only findings regarding *out*-migration come with regard to AAA spending.

[22]See also Bettin and Zazzaro (2018) on remittances, which can be considered to have a similar effect.

relief in this case, relief spending seems to have further incentivized emigration on aggregate. Our findings also speak to the potential for these distorting effects of government policy to vary by race despite being *de jure* race neutral, in this case as a result of differential eligibility for the relief.[23]

To strengthen the case that the allocation of AAA spending to land owners was responsible for the migration-inducing effects of AAA spending, panel (b) of Figure 9 interacts the AAA spending variable with a measure of home ownership, which we take as an (flawed) indicator of land ownership. Because we do not observe home ownership in 1935, the ownership variable that we use is the share of individuals by race in each county who were homeowners as reported in the 1930 census, and we standardize this measure so that it has mean zero and standard deviation one for each race.[24] Because it is taken from 1930, the ownership variable is a county-level variable rather than an individual-level variable, which limits its interpretation. When we include this interaction, the coefficients on the AAA spending variable, indicating the impact of AAA spending for counties with average home ownership, remains positive, statistically significant, and larger for blacks than for whites. Moreover, consistent with ownership moderating the effect of AAA spending, the interaction with the ownership variable is negative and statistically significant for both races, meaning that the migration-inducing effects of AAA spending were reduced in places with greater homeownership. Indeed the impact of ownership was larger for blacks than for whites.

7 Conclusion

The Great American Drought of the 1930s offers a unique case in which a major natural disaster intersects with the availability of complete-count individual-level data on migration. In this setting, we focus on racial differences in migration responses to drought exposure. Our first main result is that blacks' migration was more responsive to drought exposure than was whites'. This result is surprising—blacks were severely disadvantaged in the economy of the 1930s; given the presence of constraints that led to positive selection into migration on the basis of education, it would be

[23] On the racially disparate impacts of ostensibly race-neutral policy, see Muhammad, Sichko, and Olsson (2023), among others.

[24] Using ownership data from the 1935 agricultural census yields similar results, though these cannot be divided by race.

natural to expect that the migration of the relatively disadvantaged race would be constrained, resulting in selection into migration that led blacks to be less likely to migrate than whites. But we find the reverse, indicating that selection along one dimension need not determine the nature of selection along another.

Our explanation for blacks' greater migration response is founded on the specific nature of the US government's main relief program for the economic impact of the drought. The Agricultural Adjustment Administration (AAA) sought to provide relief by making payments to individuals in affected areas. But these payments were directed only to landowners and required them to take land out of production. This meant that individuals on other tiers of the agricultural labor force not only did not receive aid, but saw demand for labor reduced by the reduced agricultural output. Given blacks' lower likelihood of homeownership (which we take as evidence that they were also less likely to be landowners), this meant that governmental relief policy disproportionately reached whites rather than blacks. Consistent with such a mechanism explaining blacks' greater migration response to the drought, we find that controlling for a county's per-capita AAA spending attenuates, and in some cases eliminates, blacks' greater migration response. Thus, this ostensibly race-neutral policy had very different effects by race as a result of pre-existing differences between them.

Beyond helping to better understand this important setting in US history—one that remains important given the continued presence of racial differences in the modern US economy—this paper makes a number of important contributions to the literature on migration responses to natural disasters. First, a lack of individual-level data has constrained the ability to study migrant selection in response to natural disasters. A result of this has been that the degree to which disadvantaged groups may be disproportionately exposed to the impacts of natural disasters due to a different ability to respond through migration is not well understood. Our comparison of the different responses of blacks and whites is precisely such an analysis.

Our results also help to understand two mechanisms that govern whether and under what circumstances individuals respond to natural disasters through migration. The first regards attachment to land. While it has been shown in other cases that attachment to land can restrict individuals' ability to adjust to natural disaster shocks through migration, this setting demonstrates that this might be further reinforced by relief policy targeted towards landowners. Moreover, governmental relief policy has been cited as a factor helping to determine the degree to which individuals respond to disasters through migration. Such relief is generally thought of as a potential mechanism offsetting the incentive to leave after a natural disaster, but our results show that the targeting of this relief is important, and that its targeting may even increase the incentive to migrate after disasters rather than to mitigate it.

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Figures

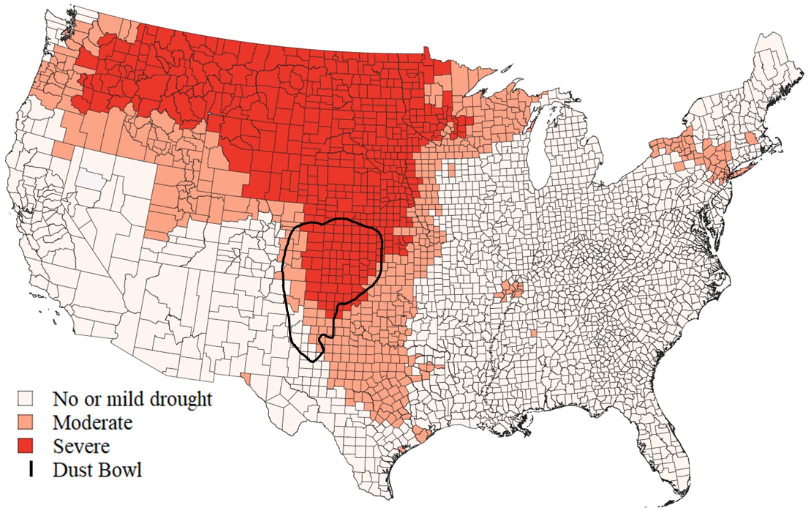


Figure 1: Drought severity 1935–1939

Note: This figure presents the geographic distribution of our main explanatory variable—the drought severity experienced by each county over the period 1935–1939. This figure also highlights (with the dark outline) the roughly 100 Dust Bowl counties according to the largest set defined by the US Department of Agriculture as counties severely impacted by wind erosion during the 1930s (Natural Resources Conservation Service 2012).

Source: Cook et al. (2010), Manson et al. (2019), and Natural Resources Conservation Service (2012)

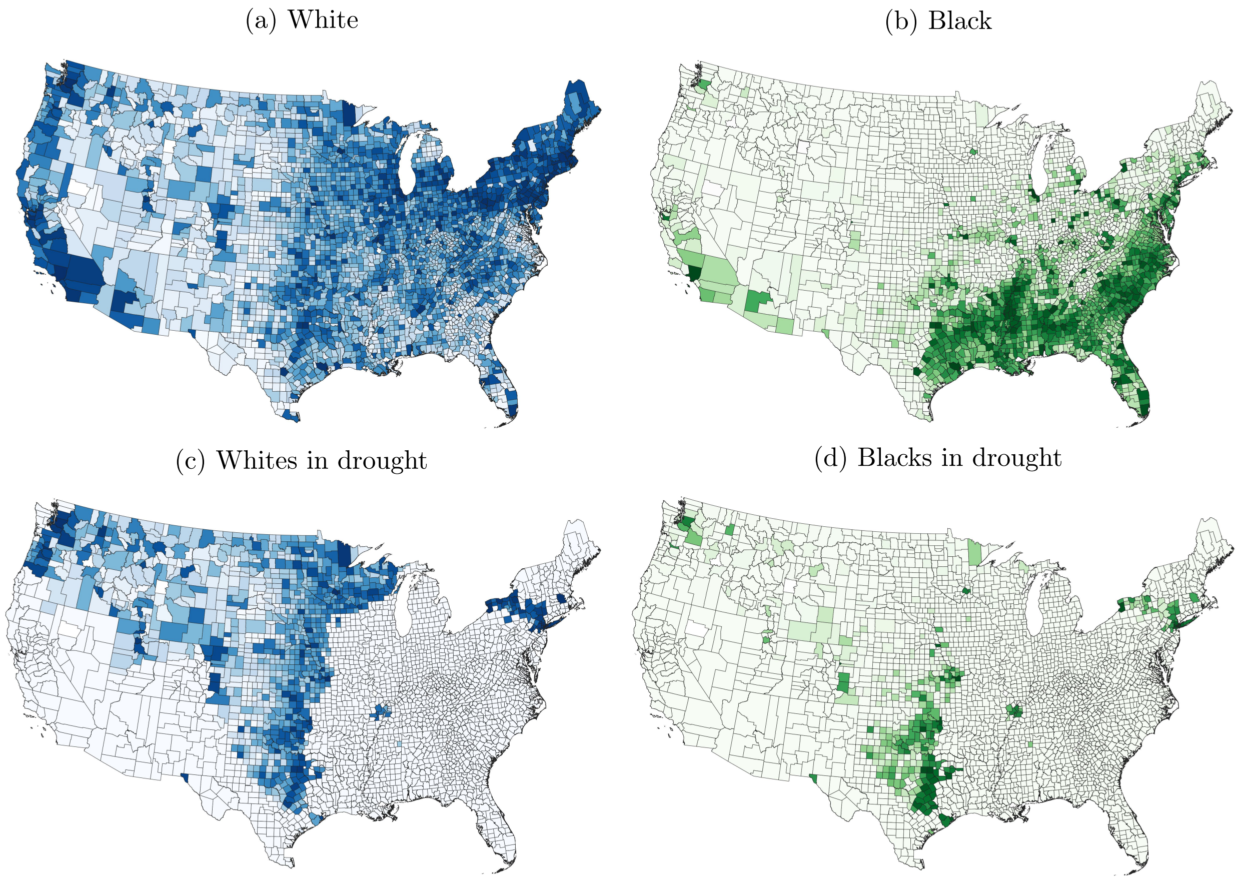


Figure 2: Population distributions by race in 1935

Note: Each figure shows the 1935 distribution of the population in question across US counties, with darker colors indicating a greater share of the total population indicated in the figure title. Panels (a) and (b) include all white adults and all black adults, respectively. Panels (c) and (d) limit attention to individuals living in counties that experienced severe or moderate drought over the period 1935–1939.

Source: Manson et al. (2019) and Ruggles et al. (2023)

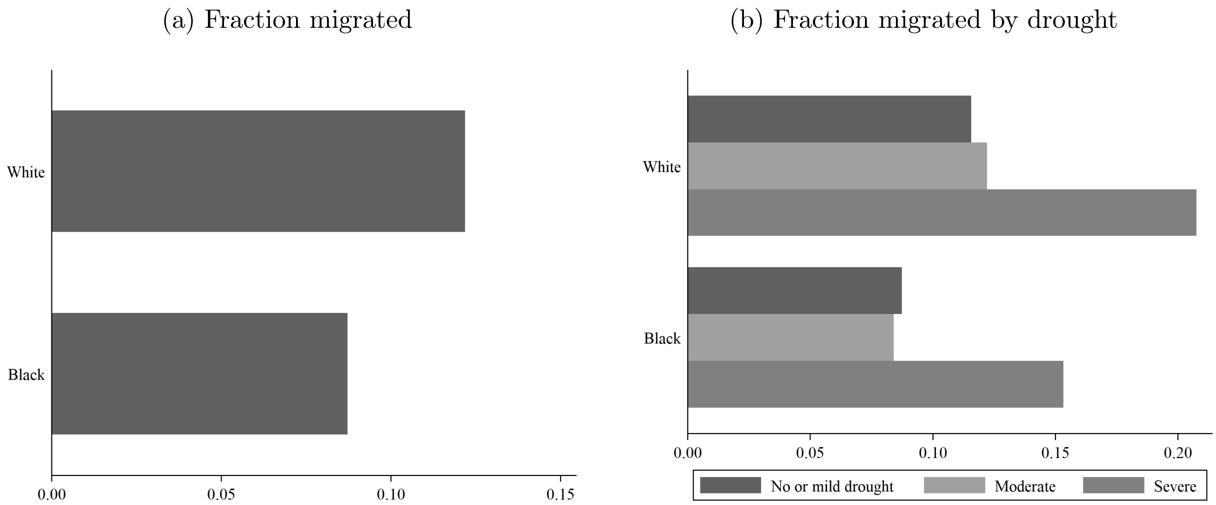
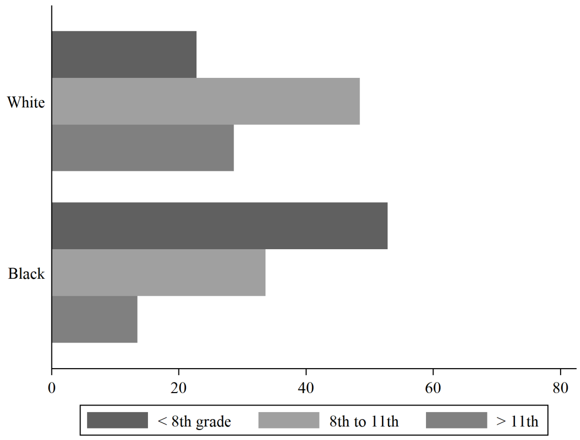


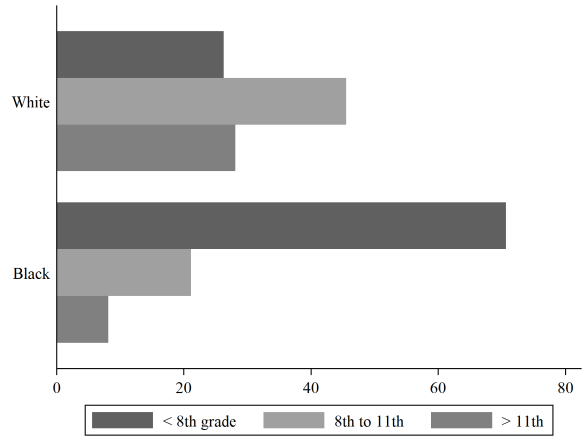
Figure 3: Migration rates

Note: This figure shows the fraction of individuals who migrated by race and drought status.

(a) Drought



(b) Non-Drought



(c) Fraction migrated by education

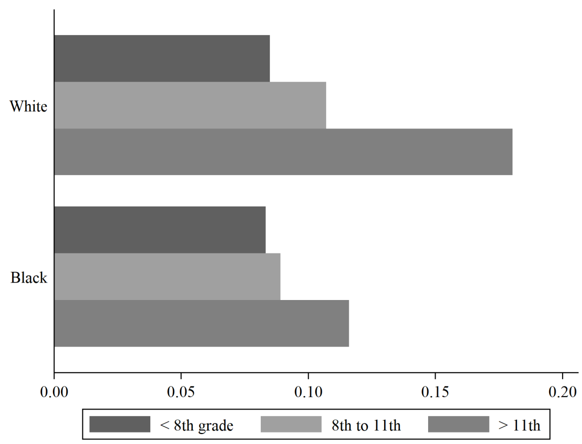


Figure 4: Education distributions by race, drought status, and migration status

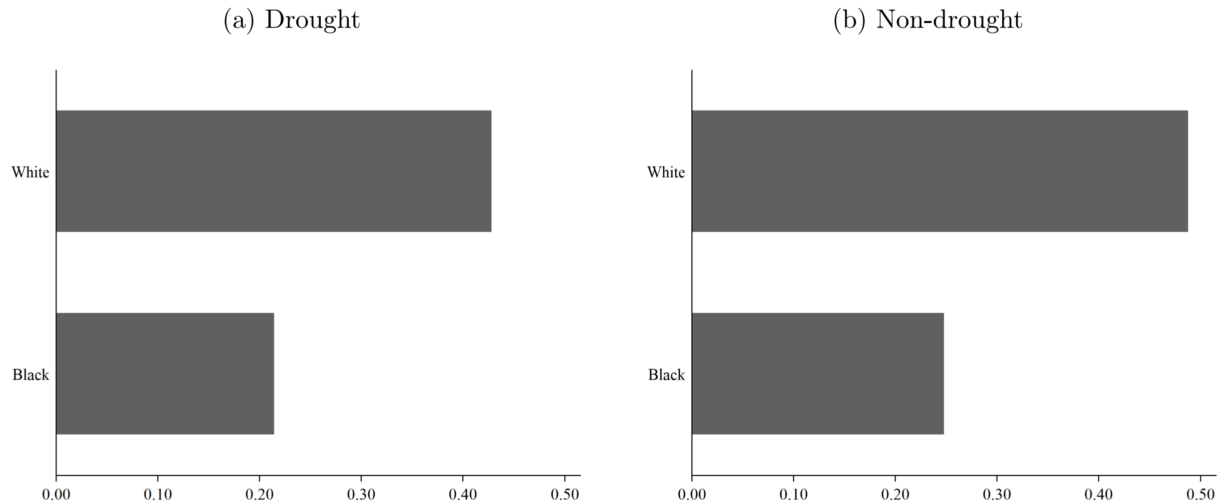


Figure 5: 1940 Homeownership by race and drought

Note: This figure presents rates of homeownership in 1940 by the drought status of an individual's 1940 county of residence over the period 1935–1939.

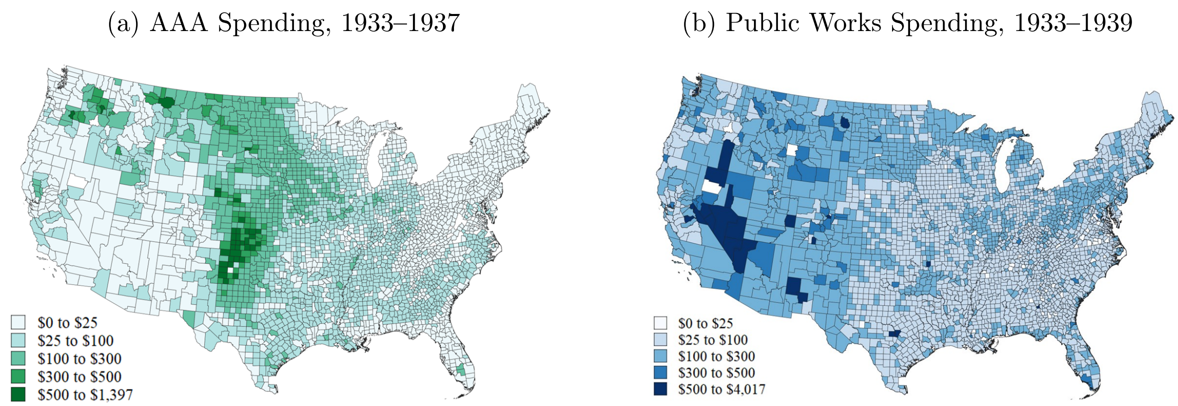


Figure 6: Per capita New Deal spending

Source: Fishback, Horrace, and Kantor (2005, 2006)

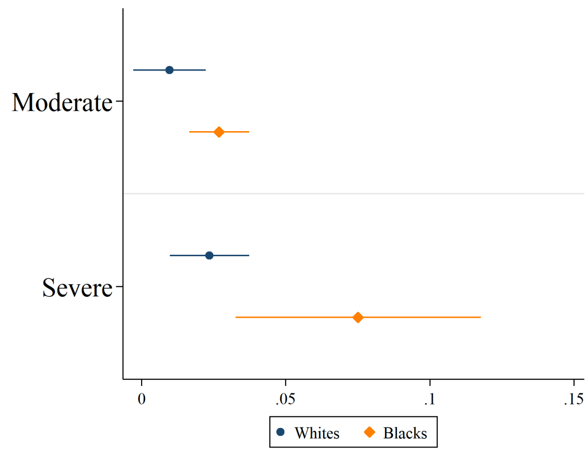


Figure 7: Migration responses to drought by race

Note: This figure shows the results of estimating the linear probability model of equation (2) separately by race. The results are also presented in Online Appendix Table A.1. Results of an analogous interaction model testing for statistical significance of differences between each race's coefficients are presented in panel (b) of Online Appendix Figure A.2. Bars indicate 95-percent confidence intervals computed using standard errors clustered at the level of the 1935 state of residence. All regressions include 1935 state fixed effects and individual- and county-level controls.

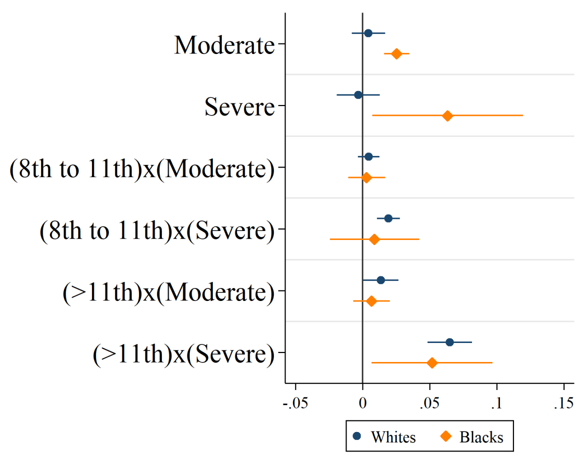
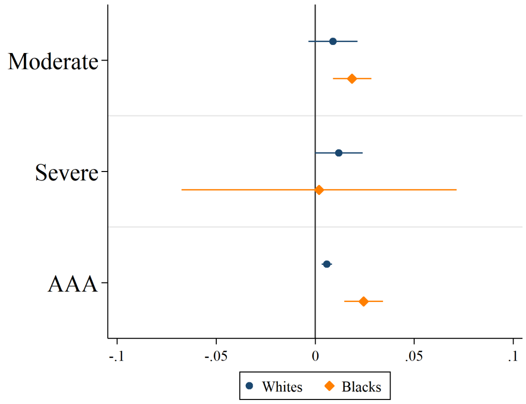


Figure 8: Migration response to drought by race and education

Note: This figure shows the results of estimating the linear probability model of equation (2) separately by race and interacting the drought category indicators with education category indicators. The results are also presented in Online Appendix Table A.2. Bars indicate 95-percent confidence intervals computed using standard errors clustered at the level of the 1935 state of residence. All regressions include 1935 state fixed effects and individual- and county-level controls.

(a) Drought and AAA spending



(b) AAA spending, home ownership, and migration

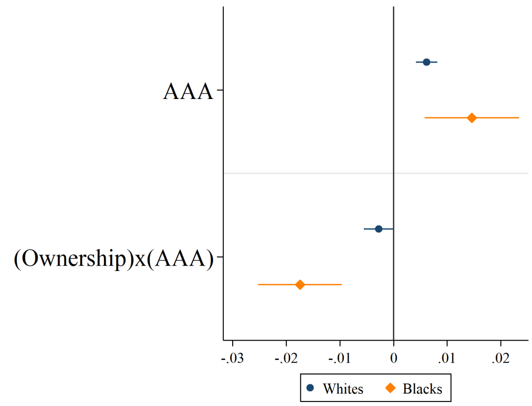


Figure 9: Migration, race, and AAA spending

Note: Panel (a) of this figure shows the results of estimating the linear probability model of equation (2) separately by race while controlling for a county's per capita AAA spending. The results are also presented in Online Appendix Table A.3, with the results in panel (a) corresponding to panel A of Online Appendix Table A.3 and the results in panel (b) corresponding to panel B of that table. In panel (b), the *Ownership* variable is the race-specific share of homeowners in each county in 1930, standardized so that each race has mean zero and standard deviation one. Bars indicate 95-percent confidence intervals computed using standard errors clustered at the level of the 1935 state of residence. All regressions include 1935 state fixed effects and individual- and county-level controls. Online Appendix Figure A.3 test for statistical significance of differences between the coefficients in panel (a).

Tables

Table 1: Summary statistics

	Non-drought	Moderate	Severe or worse
Count white	44,609,988	14,996,415	3,193,372
Count black	5,424,179	695,465	15,089
Percent			
White migrated	11.5	12.2	21.1
Black migrated	8.7	8.4	14.5
Population change 1920 to 1930	7.4	9.5	6.1
Growth in retail spending 1929 to 1939	10.7	-5.7	-11.6
1935 percent			
White	89.1	95.5	99.5
White in birth state	65.1	54.1	51.4
Black in birth state	68.4	41.1	23.5
White male	50.2	50.2	52.6
Black male	48.6	47.5	52.0
1935 average			
White age	42.3	42.3	42.4
Black age	40.3	40.3	43.1
White education in years	8.9	9.0	9.2
Black education in years	5.5	7.1	7.7
Per capita			
Public works and relief spending 1933 to 1939	$101	$118	$137
AAA spending 1933 to 1937	$34	$75	$203

Notes: This table displays average demographic variables based on the drought. The sample includes adults (i.e., those aged 18 to 65 in 1935).

Online Appendix for

Environmental Migration and Race during the Great American Drought, 1935–1940

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December 4, 2023

A Additional Tables and Figures

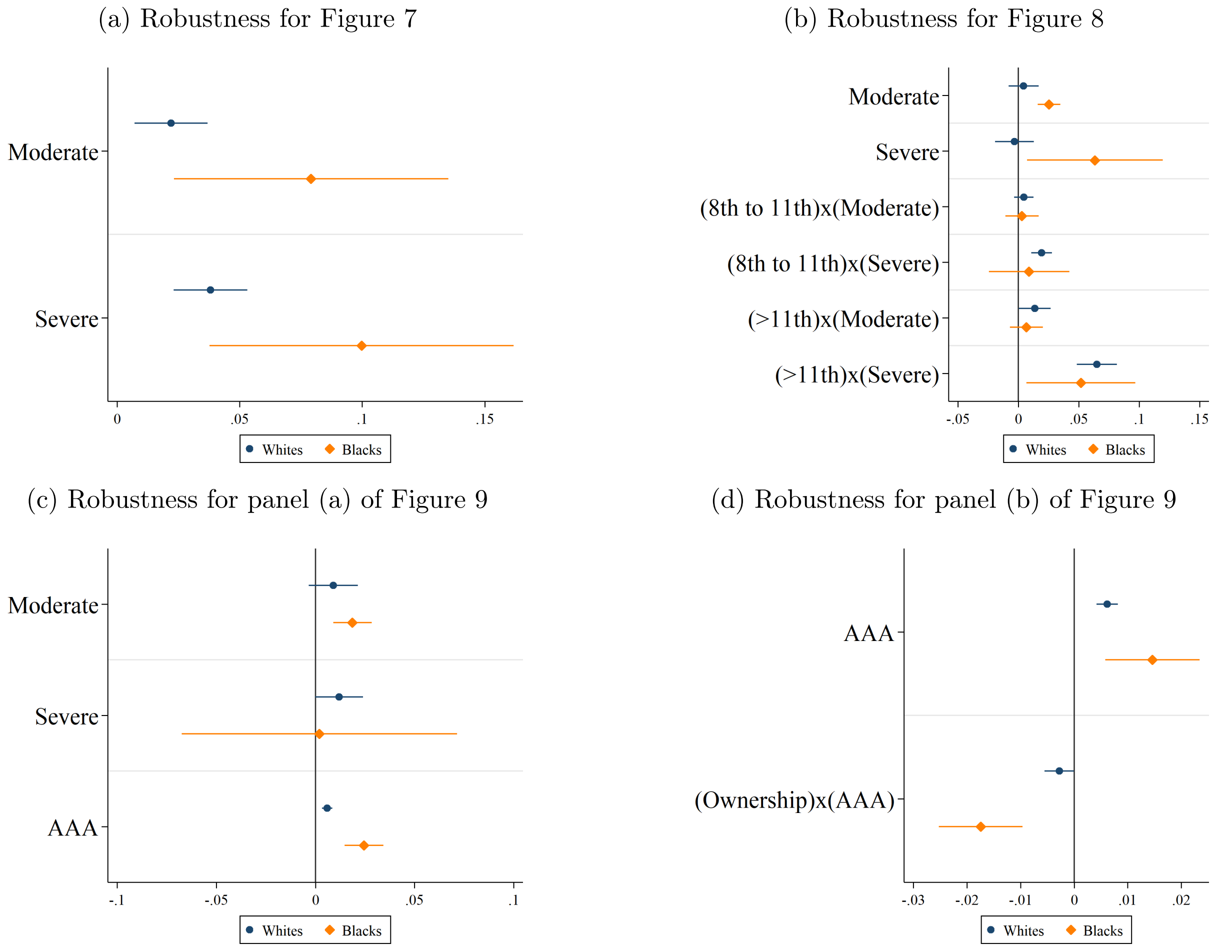


Figure A.1: Robustness to an alternate drought measure

Note: This figure repeats the paper's main results with a different definition of the drought variable. In particular the threshold between mild and moderate drought is set to 6 instead of 5 and the threshold between moderate and severe drought is set to 11 instead of 8.

(a) Logit

(b) Races interaction LPM

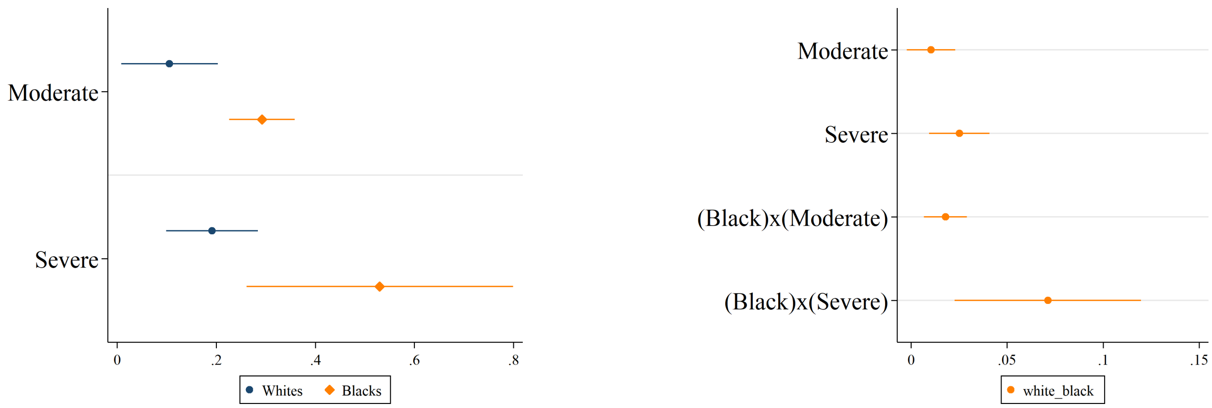
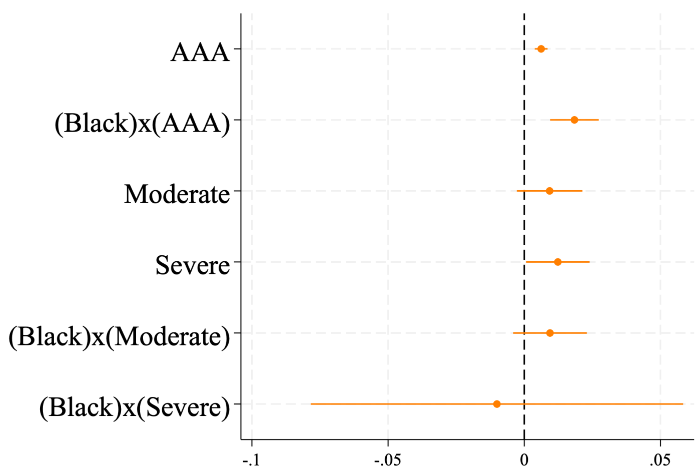


Figure A.2: Interaction and logit Robustness

Note: Panel (a) of this figure repeats the estimates of equation (2), the main results of which are presented in Figure 7, but using a logit model instead of a linear probability model. Panel (b) tests for the statistical significance of the difference between the black and white drought coefficients in Figure 7 by combining the two equations into a single interaction equation.

Figure A.3: Migration, race, and AAA spending, interactions



Note: This figure tests for statistical significance of the difference between the black and white coefficients in panel (a) of Figure 9 by combining the two regressions (one for each race) into a single interaction model.

(a) Drought and Public Works (b) Drought and Public Works: interactions

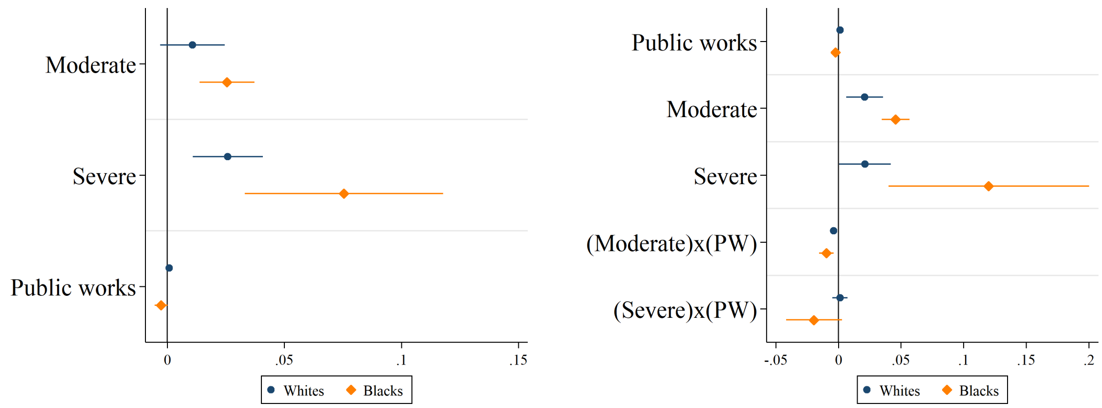


Figure A.4: Migration, race, and public works spending

Note: This figure presents analogs of panel (a) of Figure 9, replacing per-capita AAA spending with per-capita spending on New Deal public works programs. All regressions include 1935 state fixed effects and individual- and county-level controls.

Table A.1: Migration responses to drought by race

	(1)	(2)
	Migrant	Migrant
Moderate	0.011	0.027***
	(0.007)	(0.005)
Severe	0.025***	0.076***
	(0.007)	(0.021)
Observations	57,834,118	5,690,548
Sample	White	Black

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Standard errors clustered by 1935 state in parentheses. These estimates are presented in Figure 7. They come from estimating equation (2) separately for each race. All regressions include 1935 state fixed effects, and individual- and county-level controls.

Table A.2: Migration response to drought by race and education

	(1) Migrant	(2) Migrant
Moderate	0.004	0.025***
	(0.006)	(0.005)
Severe	-0.003	0.063**
	(0.008)	(0.028)
(8th to 11th)x(Moderate)	0.004	0.003
	(0.004)	(0.007)
(8th to 11th)x(Severe)	0.019***	0.009
	(0.004)	(0.017)
($>$ 11th)x(Moderate)	0.013**	0.007
	(0.007)	(0.007)
($>$ 11th)x(Severe)	0.065***	0.052**
	(0.008)	(0.022)
Observations	57,834,118	5,690,548

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Standard errors clustered by 1935 state in parentheses. These estimates are presented in Figure 8. They come from estimating equation (2) separately for each race and interacting the drought category indicators with education category indicators. All regressions include 1935 state fixed effects, and individual- and county-level controls.

Table A.3: Migration, race, and AAA spending

	(1)	(2)
	Migrant	Migrant
Panel A		
Moderate	0.009	0.019***
	(0.006)	(0.005)
Severe	0.012*	0.002
	(0.006)	(0.035)
AAA	0.006***	0.025***
	(0.001)	(0.005)
Panel B		
AAA	0.006***	0.015***
	(0.001)	(0.004)
(Owner)x(AAA)	-0.003**	-0.017***
	(0.001)	(0.004)
Observations	57,834,118	5,690,548
Sample	White	Black

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Standard errors clustered by 1935 state in parentheses. These estimates are presented in Figure 9, with the estimates of panel A presented in panel (a) of Figure 9 and the estimates of panel B presented in panel (b). The results in panel A come from estimating equation (2) separately for each race while controlling for a county's per capita AAA spending. All regressions include 1935 state fixed effects, and individual- and county-level controls.