Migrant Selection and Sorting during the Great American Drought

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America's worst drought spanned the 1930s, coinciding with the most extensive environmental migration in United States history. Nearly 100 years later, we know little about who moved and who stayed. This paper studies heterogeneity in migration from drought by relating migration decisions recorded in the 1940 census to county drought conditions. Drought increased migration primarily for individuals with a 12th-grade education or higher. Drought migrants, both women and men, left rural and urban locations and most often relocated to rural destinations. These findings highlight the importance of individual-level characteristics for adaptation to climate shocks, challenge the perception that rural-to-urban is the dominant environmental migrant channel, and document the central importance of drought for internal migration during the 1930s.

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I. Introduction

Migration is a crucial adaptive response to climate and environmental changes. The concept of migrant selection, which studies the characteristics of individuals who migrate versus those who stay, plays a key role in determining individual and broad economic outcomes resulting from environmental migration. Understanding migrant selection provides insight into the vulnerabilities of specific populations, enhances decision-making and policy formulation, is vital for crafting targeted support for affected groups, and contributes to societal resilience.

I study migration from drought, focusing on migration patterns in relation to educational levels. This study's distinctive aspect lies in analyzing individual-level migration data for the entire United States adult population, allowing for detailed documentation of drought-related migration for specific subsets within the affected population. This comprehensive approach is possible because of the convergence of a historically devastating drought and the extensive microdata from the 1940 census.

To document migration for 70 million adults, I match full-count census data with a novel dataset on county-level drought. The 1940 census includes the location of each person in 1935 and 1940 and extensive demographic information, including education, age, and race (Minnesota Population Center, 2017; Ruggles et al., 2021). I merge the census data with a dataset of county-level drought conditions from 1935 to 1939 that I created by geospatially linking the Living Blended Drought Atlas (LBDA) with the 1930 county map (Cook et al., 2010; Manson et al., 2019).[1] This dataset enables the examination of migration from drought at the individual level for the whole country. It is at the cutting edge of detail and scale for microdata used in environmental migration research.

In the empirical analysis, I employ a linear probability model with migration as the outcome, focusing on education, drought years, and their interaction as key independent variables. Migrants are

[1] The LBDA follows the methodology of the Palmer Drought Severity Index (PDSI). I also match county-level covariates, including variables measuring the intensity of the Great Depression, the New Deal spending response, and soil erosion (Fishback et al., 2005; Hornbeck, 2012).

defined as those residing in a different county in 1940 compared to 1935. Education is categorized into low (less than 8th grade), middle (8th to 11th grade), and high (above 11th grade). Drought is classified into three groups: zero to one year (*non-drought counties*), two years, and three or more years measured from 1935 to 1939, with the latter two groups referred to as *drought counties*. My analysis includes comprehensive controls for individual and county characteristics, state fixed effects, and clustered standard errors at the state level.

I find that exposure to drought led to more migration, particularly among relatively well-educated individuals. High school graduates, representing the top quartile of education, were 6.2 percentage points more likely to migrate from counties with three or more drought years than those in non-drought counties. This increase was substantial as the baseline migration rate was 16 percent among those with a high school education. The trend of increased migration was consistent for highly educated individuals, regardless of sex and whether they were from rural or urban origins, with some differences in the magnitude of the response. There was a smaller increase in migration among those with an 8th- to 11th-grade education and no significant change for those with less than an 8th-grade education, who constituted 43 percent of the adult population. Therefore, while highly educated individuals were more likely to move away from drought-affected areas, less educated people tended to stay.

I contend that insufficient financial resources were a barrier to migration for many individuals. A survey of those who did not migrate frequently cites lacking funds for moving as the primary reason for staying, as illustrated by one respondent's remark, "We didn't have money to go anywhere so we just existed" (Riney-Kehrberg, 1994). Consistent with the theory that limited liquidity constrained environmental migration, I show that the severity of the Great Depression from 1929 to 1935, which restricted access to credit and cash, further exacerbated positive selection into migration from drought, supporting the notion that financial capacity was a crucial determinant in drought-related migration.

Regarding where migrants went, I show that drought increased short-distance (inter-county) and long-distance (inter-state) migration. For instance, high school-educated individuals from counties experiencing three or more drought years were 2.5 percentage points more likely to migrate within the same state and 3.4 percentage points more likely to migrate to a different state than their counterparts in non-drought counties. These increases were substantial, considering the baseline interstate migration rate from non-drought counties was 4.6 percent.

Most drought-induced migrants relocated to rural non-farm locations. Three or more drought years increased migration to rural non-farm destinations by 3.9 percentage points and to urban destinations by 1.8 percentage points while not affecting migration to farm locations among the highly educated.[2] Despite no overall change in migration rates for those with less than an 8th-grade education, a distinct pattern emerges when distinguishing destination type: increased migration to farms (potentially less expensive moves) and decreased migration to urban and rural non-farm areas (potentially more expensive moves). These trends, accounting for factors including proximity to cities, origin type, and state fixed effects, offer insights, especially considering the focus on rural-to-urban migration of previous research, and demonstrate the nuanced ways shocks can simultaneously elevate and reduce different types of migration.

This paper contributes to the field of environmental migrant selection by extending the insights of the existing literature, which often focuses on migration trends related to the average wealth of geographic areas.[3] Previous studies have observed that out-migration is more common in middle- and high-income areas, a trend typically attributed to the financial aspects of migration. However, these studies usually do not specify the exact demographic profiles of migrants, and migration from wealthier areas does not necessarily mean that wealthier individuals are those relocating (Piantadosi et al., 1988).[4] Building on this

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[2] In this study, cities are defined as urban areas with over 20,000 residents in 1940, aligning with the Integrated Public Use Microdata Series (IPUMS) definition of cities. Rural areas encompass metro areas with fewer than 20,000 residents and unincorporated areas. This deviates from the standard IPUMS urban-rural classification, which considers areas with 2,500 or more residents as urban. *City* and *urban* are used interchangeably here to refer to larger urban areas with a population of 20,000 or more. This focus is due to the availability of 1935 city status data in the full-count 1940 census.

[3] See Chiquar and Hanson (2005); Piguet (2010); Angelucci (2015); Cattaneo and Peri (2016); Bazzi (2017); Benonnier et al., (2019); and Piguet (2022).

[4] Assuming that higher migration from wealthy areas implies higher migration among wealthier individuals is an example of the ecological fallacy: the erroneous assumption that a statistical relationship observed for a group necessarily applies to individuals within that group.

foundation, my research shows that individuals with higher education, an indicator of individual wealth and human capital, responded to drought conditions by migrating, whereas less educated individuals did not. This result shows how different socioeconomic groups reacted to an environmental disaster and is among the first research to clearly document environmentally induced positive selection.

The observed pattern of increased positive selection into migration and more migration among the highly educated across all analyzed demographic subsets—women and men and urban and rural residents—suggests that environmental factors may consistently influence diverse groups in specific contexts. This finding is noteworthy, particularly in light of extensive research that points to varied responses to environmental shocks (Cattaneo & Peri, 2016; Bazzi, 2017; Sedova & Kalkuhl, 2020; Hornbeck, 2023), including the main results of this paper. Amidst this heterogeneity, a degree of uniformity emerges, providing a more comprehensive picture of how populations react to environmental challenges.

Previous research emphasizes rural-to-urban environmental migration (Cohen, 2016; Cattaneo & Peri, 2016; Peri & Sasahara, 2019). However, taking the entire migration history of the 1930s, I find that drought migrants typically relocated to rural non-farm locations, controlling origin type, distance to the nearest city, and studying within state variation with fixed effects. In light of these results, focusing on rural-to-urban migration may obscure the experience and outcomes of many migrants, as during the 1930s. The shock's underlying characteristics and the affected area’s economic structure are essential to the likely consequences for rural and urban migrant flows. Drought, especially the heat associated with drought, impacts people and the economy outside of its impact on agriculture (Deschênes & Moretti, 2009; Hsiang, 2010; Dell et al., 2012; and Barreca et al., 2016). Therefore, local cities may not be refuges for people displaced by drought to the extent they are for related environmental shocks (such as soil erosion), which have a more pointed impact on agriculture.

Finally, I contribute to environmental migration research during the 1930s in the United States. This was a pivotal decade, as the flow of migrants to the Great Plains reversed after decades of population growth (Gutmann, 2018). Previous research has focused on the Dust Bowl (Long & Siu, 2018; Worster, 2004; Hurt, 1981) and, more recently, erosion (Hornbeck, 2012; 2023). However, the Dust Bowl and erosion were endogenous to farming practices specific to this era. This endogeneity means that studying the Dust Bowl and erosion is, in part, studying the impact of an environmental shock and, in part, studying the impact of human mismanagement. The underlying exogenous shock of drought has been largely ignored, and drought as a climatic phenomenon remains among the most common and destructive shocks.

Analyzing the influence of America's worst drought at the individual level enables studying environmental migrant selection and sorting on a geographic and population scale that is impossible for most other places and times. In doing so, this paper builds a wide-ranging and detailed view of how an environmental catastrophe influenced migration, thereby altering the population and human capital distribution of the United States. These details concerning mass migration resulting from drought are among the most salient and extensive in anticipating the repercussions of current and future shocks.

II. Background: Environmental degradation and migration

[Figure 1 here]

The 1930s drought, the most severe 10-year drought in U.S. history (Heim, 2017), began in 1930 in the southeast and persisted across the nation to varying degrees until 1939 (Seagar et al., 2008; Sichko, 2021). During the latter part of the decade, the drought predominantly affected the northern Great Plains and Mountain West (Figure 1). Despite the drought's severity, impact, and prolonged duration, there is a paucity of research on its consequences. This research gap can be attributed, in part, to an intense focus on a particular southern Great Plains subset of the drought known as *the Dust Bowl* and to a lack of detailed geographic data on drought severity, which was not developed until relatively recently. This section describes the relevant literature, emphasizing the Dust Bowl and elucidating its differences from the more widespread issues of drought and erosion.

Drought was associated with two connected yet separate environmental shocks: erosion and dust storms. Drought and dust storms centered on the Great Plains, a semi-arid and drought-prone region in the middle of the United States. The aridity and climatic volatility of the Plains initially deterred European Americans from settling in the region (Webb, 1959). However, this reluctance shifted to opportunism and rapid agricultural expansion in the late 19th and early 20th century, coinciding with an unusually wet period on the Plains (Libecap & Hansen, 2002). Therefore, compared to earlier droughts, the 1930s drought met topsoil exposed by the agricultural boom. The exposed topsoil and shallow-rooted crops facilitated dust storms of unprecedented severity and frequency (Hansen & Libecap, 2004).

Dust storms garnered national attention by the mid-1930s, and the term "Dust Bowl" was coined by the reporter Robert Geiger concerning the most severely affected area in the southern Great Plains after the intense storm on April 14, 1935, "Black Sunday." The Soil Conservation Service (SCS) in the U.S. Department of Agriculture adopted Geiger's Dust Bowl terminology to define 20 counties surrounding the Oklahoma panhandle as the area most adversely affected by dust storms and wind erosion (Joel, 1937; Cunfer, 2011), labeled *core Dust Bowl* in Figure 1 panel (b). Moreover, approximately 100 more counties in the southern Great Plains were designated as having suffered severe wind erosion, also shown in Figure 1 panel (b). Historians often call these counties the Dust Bowl (Hurt, 1981; Worster, 2004; Riney-Kehrberg, 1994; Cunfer, 2011). Furthermore, Porter and Finchum (2009) quantitatively show that this region corresponds to what is traditionally termed the Dust Bowl in scholarly vernacular and colloquially within the region. Finally, the mapping of dust storm frequency highlights this area as the most affected (Bolles et al., 2019; Lee & Gill, 2015), and it is these counties that most research concerning the Dust Bowl focuses on.

This Dust Bowl region differs from the area studied in recent economic research on soil erosion across the Great Plains (Hansen & Libecap, 2004; Hornbeck, 2012; 2023). Hansen and Libecap (2004) and Hornbeck (2012; 2023) substantially extend the geographic scope, offering a broader understanding of environmental degradation. Moreover, they focus on erosion specifically, whereas the traditional Dust Bowl was defined by dust storms, erosion, and drought, and while these phenomena are related, they are also distinct.[5] Both dust storms and erosion were endogenous to 1930s farming practices, which were not well suited for the Great Plains (Worster, 2004; Webb, 1959). Other severe and prolonged droughts on the plains have not resulted in similar severity or frequency of erosion and dust storms (Hansen & Libecap, 2004).

Migration has likely been the most studied consequence of the Dust Bowl and erosion (Hurt, 1981; Gregory, 1991; Riney-Kehrberg, 1994; Worster, 2004; Hornbeck, 2012; Long & Siu, 2018; Hornbeck, 2023). For the 20 core Dust Bowl counties, migration rates were high during the 1930s and the 1920s (Long & Siu, 2018). The net decline in population for these 20 counties during the 1930s was largely due to a decrease in in-migration rather than an increase in out-migration. More broadly, eroded counties throughout the Plains saw significant population declines during the 1930s, 1940s, and 1950s (Hornbeck, 2012). Regarding who moved, the average migrant from more-eroded counties had more education than non-migrants but fewer years of education than other migrants from the Great Plains (Hornbeck, 2023).[6]

Outside the bounds of the Dust Bowl, even by its broadest definition, people left hot and dry areas throughout the western U.S. in the late 1930s (Gutmann et al., 2016). In the realm of widespread drought, I expand on previous research by studying who moved and where migrants went, distinguishing by individual education attainment. Migrant selection and sorting are central topics to climate-induced migration because individual characteristics, specifically human capital, are vital to determining whether someone moves. Furthermore, much of the literature on the Dust Bowl is qualitative (rich in details and personal accounts) but not aimed at statistically estimating how environmental conditions impacted economic outcomes. Hornbeck (2012; 2023) and Gutmann et al. (2016) differ from previous 1930s environmental migration research because they use local variation to estimate how conditions impacted

[5] Drought was the environmental shock that heated and dried the soil. Then, weather systems and strong winds swept up billions of tons of soil (wind erosion), culminating in massive dust storms that traveled hundreds or thousands of miles.

[6] A few factors to consider when comparing my results to Hornbeck (2023). First, erosion and drought were related but not equivalent environmental shocks. The worst drought was northwest of the worst erosion on the Great Plains. Moreover, when the rains returned in 1940, the impact of the drought receded quickly, apart from the erosion damage, which was a long-term problem. Finally, Hornbeck (2023) studies whether the average migrant was positively or negatively selected, whereas I study whether drought increased the propensity of individuals to migrate differential by human capital. These topics are discussed more in the Section VII.

migration relative to other factors. In this vein, I use county variation in drought intensity to isolate the influence of drought. Finally, as noted above, previous research focuses on the Dust Bowl and erosion. These phenomena were partially caused by drought and partially by inappropriate land stewardship. Focusing on drought allows us to examine the immediate impact of an environmental shock, enhancing our comprehension of the environment's influence.

Environmental migrant selection

This paper also contributes to the active field of research on environmental migration, and this section provides a conceptual overview, focusing on selection. The decision to migrate balances the expected benefits of relocating and the costs of moving. This computation is complicated, influenced by push and pull factors, and shaped by individual characteristics. Human capital or skills, which enable migration and determine the expected returns of a move, are especially important (Sjaastad, 1962; Borjas, 1987; Chiquiar & Hanson, 2005; Armstrong & Lewis, 2012; Abramitzky et al., 2012; Collins & Wanamaker, 2014).

When an environmental shock affects a region, it intensifies push factors for migration by negatively altering living conditions. This situation often leads to increased migration from affected areas.[7] However, numerous studies show limited, negligible, or negative effects on out-migration in response to environmental shocks.[8] While these findings may seem counterintuitive if only the shock's influence on push factors is considered, they might be explained by the shock's impact on people’s financial resources, which are essential for funding migration. Specifically, the shock might lead to people wanting to move but lacking sufficient cash or credit.

[7] See Reuveny & Moore (2009); Feng et al. (2010); Massey et al. (2010); Boustan et al. (2012); Hornbeck (2012); Bohra-Mishra et al. (2014); Hornbeck & Naidu (2014); Mastrorillo et al. (2016); Kleemans & Magruder (2018); and Hoffmann et al. (2020).

[8] See Bryan (2014), Angelucci (2015), Nawrotzki & DeWaard (2018), Beine & Parsons (2017), and Cattaneo et al. (2019).

Empirical research aligns with the theory that liquidity constraints impede migration driven by environmental factors. Observations often show higher out-migration rates in wealthier regions, unlike lower-income areas, which see reduced migration (Kleemans, 2015; Cattaneo & Peri, 2016; and Bazzi, 2017). Nonetheless, such patterns do not definitively indicate that it is affluent people in particular who migrate, and this raises a crucial question: Does higher out-migration from affluent areas occur due to wealthier individuals moving, or is it a result of broader factors such as better transportation infrastructure? My research contributes to this discourse by being among the first to examine individual-level migration responses to an environmental shock, focusing on migration differentiating by human capital.

Migrant selection models provide a framework for considering how environmental shocks may shape individual-level selection (Roy, 1951; Borjas, 1987; McKenzie & Rapoport, 2010). Drought is expected to increase the push factors for migration and restrict cash, credit, and liquidity. Therefore, the liquidity constraint may bind more often, especially for those with less wealth, amplifying positive migrant selection. Simultaneously, mitigating factors, including property ownership and occupation, may act against drought-induced positive selection or even lead to negative selection. Homeownership, often linked to decreased migration (Helderman et al., 2006; Hämäläinen & Böckerman, 2004), might dampen responsiveness during short-lived shocks such as drought. Occupation is also essential because drought disproportionately affects specific sectors, such as agriculture and manual labor (Kilimani et al., 2018; Ding et al., 2011), potentially prompting more migration from these sectors, typically associated with lower education levels. Finally, individuals with higher-paying jobs and more wealth have greater adaptability to economic downturns, given less immediate need for income (Mian et al., 2013).

The dynamics of environmental shocks on migrant selection are complex. They can induce positive selection through liquidity constraints or negative selection influenced by ownership and occupation. Empirical evidence helps elucidate the relative significance of these factors and is instrumental in advancing our understanding of the mechanisms that underpin decision-making in the face of environmental variability.

III. Data Construction

The overlap between the 1940 census and the 1930s drought creates an opportunity to analyze how a monumental shock impacted migration by individual characteristics. The primary data are first the full-count 1940 census and second drought conditions from 1935 to 1939 (Cook et al., 2010; Manson et al., 2018; Ruggles et al., 2021).[9] These datasets allow me to match adults aged 18 to 65 in 1935 to drought conditions at the county level based on their self-reported 1935 location.

The 1940 census forms the foundation of analysis.[10] This census was the first to record the place of residence five years prior and captures the entire population's internal migration from 1935 to 1940. The 1940 census also recorded extensive demographic information for each person. These variables are used as controls, as documented in the Empirical Framework section. The variable *highest grade* is central to this study because it measures 1935 human capital for the adult population, allowing the study of migration differentiating by education level.

To assess the impact of drought, I match the census records with county-level drought conditions. The Living Blended Drought Atlas (LBDA), made accessible by the U.S. National Atmospheric and Oceanic Administration (NOAA) and detailed by Cook et al. (2010), provides historical drought data. The LBDA is a recent iteration of the Palmer Drought Severity Index (PDSI), the most widely recognized method for gauging variations in drought severity across temporal and spatial dimensions (Palmer, 1965).[11]

Meteorological drought, as measured by the PDSI, is characterized by a prolonged and abnormally low moisture level relative to the local average (Palmer, 1965). The PDSI employs a water balance model

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[9] I exclude 1940 as a potential drought year because the 1940 census was enumerated in March of 1940. There was very little drought in 1940, and its inclusion or exclusion does not impact the results.

[10] The choice to focus exclusively on the 1940 census for this study, despite recognizing the theoretical benefits of an approach using earlier migration data to establish pre-trends, is driven by several critical considerations. The span from 1935 to 1940 provides an unparalleled opportunity to study environmental migrant selection, thanks to unmatched data quality and comprehensiveness. Specifically, I measure migrant selection precisely and without the worry of bias induced through false linkages and selection into linkage, as detailed in the online Appendix.

[11] Alley (1984) offers a complete detailing of the calculations that create the PDSI. Alley (1984) also critiques aspects of the PDSI as used in the 1980s. Most problems are addressed in later index computations, including the LBDA.

based on climate data to quantify drought conditions. The LBDA used in this research, a modernized drought index employing the basic PDSI methodology, provides a continuous numerical index of drought derived formulaically from instrument records, including heat, rain, wind, soil type, runoff, and evaporation. Covering a grid of 11 thousand points across North America, the LBDA calculates drought severity relative to conditions measured during the calibration period from 1928 to 1978 (Cook et al., 2010). The LBDA lacks geographic variables that enable direct linkage to census data. To use the LBDA in connection with census data, I geospatially match it with the U.S. county map and calculate the average annual drought within each county's boundary lines (Manson et al., 2019). Then, I match this drought dataset directly with the 1940 population census based on individual 1935 locations.

While the LBDA measures drought annually, I observe people’s locations only in 1935 and 1940. Accordingly, I construct a drought variable to capture exposure over multiple years. The primary independent variable in this research is the count of moderate or worse drought years (drought index value of less than -2) in each county from 1935 to 1939. I use *moderate* as the threshold because this level of drought is anticipated to cause damage to crops and pastures, as well as decrease the volume of streams, reservoirs, and wells, leading to some water shortages, and counting moderate or worse drought years is a straightforward measure of drought exposure over a multi-year period.[12]

I supplement census and drought data with several other datasets, including county-level measures of Great Depression severity, New Deal spending, and soil erosion (Fishback et al., 2005; Hornbeck, 2012). These variables allow me to control for important events, trends, and other variables. In summary, combining individual-level migration data and county-level drought metrics, along with other county-level controls, positions the data for this study on the frontier of environmental migration research.

[12] Alternative definitions of drought severity over multi-year durations, such as the summation of total yearly drought, are also valid metrics. The calculation of multi-year drought using the summation of yearly drought is elaborated upon in the Appendix, which includes robustness checks for the results. The qualitative description of the impact of moderate drought used above is from the U.S. Drought Monitor. The U.S. Drought Monitor is jointly produced by the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration.

IV. Descriptive statistics

This section offers an overview of drought and migration, including some county-level aggregate migration statistics to give a broad perspective on migration patterns. This initial analysis at the county level serves a descriptive purpose and is confined to this section of the paper. In contrast, this research's primary focus is on individual-level data. Therefore, the latter part of this section details migration data at the individual level.

From 1935 to 1939, a prolonged drought impacted a considerable portion of the United States, as depicted in Figure 1 panel (a). The states most severely affected included Kansas, Nebraska, North Dakota, South Dakota, Montana, Idaho, Washington, Oregon, Minnesota, and Wyoming, covering a more extensive and geographically distinct area compared to the traditional Dust Bowl boundaries (Hurt, 1981; Riney-Kehrberg, 1989; Worster, 2004; Long & Siu, 2018), as illustrated in Figure 1 panel (b). Notably, the drought centered on the Northern Plains, Midwest, and Mountain West, deviating from the focus of Dust Bowl-related research, which has predominantly concentrated on the Southern Plains.

[Figure 2 here]

As Figure 2 indicates, drought years were correlated with net out-migration.[13] Specifically, counties experiencing zero to one drought year, referred to as non-drought counties, saw a modest increase of 0.5 percent in the adult population due to migration within the five years. In contrast, counties with two or more drought years faced substantial population decreases by 1940, with losses of 2.0 percent for two drought years and 7.2 percent for three or more drought years.

One concern is the potential for pre-existing net out-migration from counties affected by drought, predating the actual drought events. Due to data constraints—the 1940 census being the first to record individuals' residences five years prior—direct calculation of net migration for earlier periods is impossible. However, population trends and historical context offer insight. Categorized by the subsequent drought

[13] As calculated for this paper, net migration is defined as the difference between the number of individuals who left and those who entered a county, normalized by the county's population aged 18 to 65 as of 1935.

years from 1935 to 1939, all categories experienced population growth between 1920 and 1930.[14] Furthermore, the most substantial net out-migration during the late 1930s occurred on the Great Plains, as Figure 3 illustrates. This pattern departed from the long-standing population increases on the Plains from the 1870s through the 1920s (Gutmann et al., 2018).

[Figure 3 here]

County-level net out-migration in the late 1930s was a function of differential in- and out-migration flows. For example, the increase in population in non-drought counties resulted from 15.0 percent of the population leaving and the equivalent of 15.5 percent arriving. By contrast, the 7.2 percent decrease in populations of counties experiencing three or more drought years is the net result of 21.7 percent of the 1935 population leaving and only 14.5 percent arriving. These statistics highlight that the depopulation of drought-affected counties was due to higher departure rates and lower arrivals. This observation is vital, as many migration studies focus solely on net population changes without differentiating between incoming and outgoing migration.

[Figure 4 here]

Figure 4 illustrates out-migration segmented by education level, revealing two key observations. First, the most pronounced out-migration was in the Great Plains and the western United States. Second, there was a clear trend where out-migration rates escalated with increasing levels of education, as evidenced by progressively darker shades in each subfigure.

[Table 1 here]

In detailing individual-level migration, Table 1 displays the total number of migrants and calculates the percentage of migrants by specific categories: women and men, and urban and rural locations in 1935. Migration from drought was widespread through these categories as the migration rates for women and men and from urban and rural settings all roughly doubled when comparing non-drought counties to those

[14] For the three drought categories, the respective population change was 7.9, 9.8, and 4.6 from 1920 to 1930s, as calculated using log change in population from Fishback et al. (2005). These statistics include births and deaths, international migration, and all ages.

experiencing three or more drought years. This observation is descriptive, and the subsequent discussion shows that several covariates influence the relationship between drought and migration and necessitate the formal analysis of the relationship, which is the focus of the next section.

[Figure 5 here]

Regarding destinations, Figure 5 shows that the highest in-migration occurred in western and southwestern counties, reflecting predominant westward migration. This westward trend occurred for all education levels, and migrants moved approximately 95 miles west on average. These moves west substantially altered the population distribution of the U.S., as observed by referring back to Figure 3.

[Table 2 here]

Table 2 breaks down individual migration patterns by distance and destination type. In non-drought counties, migration was mainly within the same state (county-to-county migration). With the drought, a shift towards out-of-state migration occurred, signifying a notable departure from typical short-distance migration patterns. The increased frequency of out-of-state migrations from drought-impacted areas is critical to the drought's influence on population distribution, as the drought region lost population rather than undergoing a local reorganization.

Table 2 also delineates destinations by type, distinguishing between rural non-farm, farm, and urban destinations. Mostly, migrants opted for either urban or rural non-farm destinations, consistent with the overall population distribution, with only 18 percent living on farms in 1940. Destination type shifts in relation to drought years. However, describing drought's influence on this trend is challenging outside of regression analysis, given the underlying differences between drought and non-drought counties.

[Table 3 here]

Finally, Table 3 categorizes demographic data by drought years, showing that counties affected by drought typically had rural, agricultural demographics, predominantly white populations, and many residents born outside the state. These trends align with historical settlement patterns in drought-prone areas like the Great Plains.[15] Table 3 also includes basic information on how drought related to the Great Depression and New Deal spending. Notably, the severity of the Depression, as used in the *Selection Mechanism* subsection and measured by retail sales growth from 1929 to 1935, does not exhibit a clear correlation with drought years in the late 1930s. This relationship contrasts with Depression severity measured over a longer period, from 1929 to 1939, which does show a clear relationship with drought years.

In response to the Depression, the Roosevelt administration initiated significant federal spending programs in 1933. Most of these funds were channeled through Public Works and Relief spending, which correlated with drought years. However, Public Works and Relief spending was not explicitly targeted to drought-affected counties, unlike the funding provided under the Agricultural Adjustment Act, which was overtly allocated to counties suffering from drought, erosion, and dust storms. Studying the influence of New Deal spending on migration is beyond the scope of this paper and is detailed by Fishback et al. (2006).

V. Empirical framework

I estimate a linear probability model (LPM) of migration. The rationale for using an LPM is its simplicity in interpretation, particularly when assessing the impact of drought on an individual's likelihood to migrate and evaluating the magnitude of interaction terms. The identifying assumption is that migration patterns from drought-affected and non-drought counties would have been comparable without drought. This assumption is plausible due to the inherent randomness of drought intensity within regions, extensive inclusion of control, and geographic fixed effects, as described below.[16] For robustness, the main results

[15] The region most affected in the late 1930s was inherently arid and drought-prone, influencing historical migration and settlement patterns as detailed in the Background section. However, the distribution of drought within ecological regions such as the Great Plains was relatively random, providing a basis for the empirical framework in the following section, which utilizes geographic fixed effects.

[16] As mentioned in the previous footnote, certain regions in the U.S. experience varying degrees of aridity and drought frequency. Nonetheless, the severity and occurrence of drought, particularly when comparing within a region, are determined by relatively unpredictable climatic factors.

are also estimated using a logit model, the details of which are provided in Appendix Table A2. Equation 1 is written in vector notation for compactness here and written out in the following footnote.[17]

$$(1)\ M_i = \alpha + \beta_1 E_i + \beta_2 D_c + \beta_3 (D_c \times E_i) + \theta_1 X_{i1935} + \theta_2 X_{c1935} + \gamma_{g1935} + \gamma_a + \varepsilon_i$$

The outcome variable M_i is a binary variable that takes a value of one if individual *i* was in a different county from their 1935 county in 1940 and a value of zero otherwise. Migration status is regressed on a vector of indicator variables for the number of drought years at individual *i's* origin county (D_c), a vector of indicator variables for individual *i's* education attainment (E_i), a vector of interaction terms between drought years and education attainment ($D_c \times E_i$), geographic fixed effects (region, state, or county) (γ_{g1935}), age fixed effects γ_a, a vector of 1935 individual characteristics (X_{i1935}), a vector 1935 county characteristics (X_{c1935}), and an error term (ε_i).

The vector of educational attainment indicator variables (E_i) contains an indicator variable for whether an individual had an 8th- to 11th-grade education and an indicator variable for whether an individual had a 12th-grade education or higher. The omitted category is individuals with less than an 8th-grade education. The coefficients on the vector of education indicators (β_1) indicate whether individuals with higher educational attainment were more inclined to migrate within the omitted drought group. Positive β_1 values indicate positive selection into migration: people with more education were moving more. The vector of indicator variables for the number of drought years (D_c) contains an indicator variable for whether a county experienced two drought years and an indicator for whether a county experienced three or more drought years. The omitted category is counties that experienced zero or one drought year.[18] The β_2 values estimate how drought years impacted migration decisions for the omitted education group.

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[17] $M_i = \alpha + \beta_{11}(8th\ to\ 11th\ grade)_i + \beta_{12}(12th\ grade\ or\ higher)_i + \beta_{21}(2\ drought\ years)_c + \beta_{22}(3\ or\ more\ drought\ years)_c + \beta_{31}(8th\ to\ 11th\ grade)_i(2\ drought\ years)_c + \beta_{32}(8th\ to\ 11th\ grade)_i \times (3\ or\ more\ drought\ years)_c + \beta_{33}(12th\ grade\ or\ higher)_i \times (2\ drought\ years)_c + \beta_{34}(12th\ grade\ or\ higher)_i \times (3\ or\ more\ drought\ years)_c + \gamma_{s1935} + \gamma_a + \theta_1 X_i + \theta_2 X_c + \varepsilon_i$

[18] I include counties with one drought year in the excluded group because most U.S. counties experienced at least one moderate or worse drought year from 1935 to 1939. Given normal climatic fluctuations, one moderate or worse

The vector of interaction terms between drought years and education attainment is $(D_c \times E_i)$. The omitted category is individuals with less than an 8th-grade education from a non-drought county. The interaction term coefficients (β_3) estimate the difference in migration propensity between individuals with higher levels of education in drought counties relative to the omitted group. Positive β_3 values indicate that the difference in migration propensity between more highly educated people and less educated people was larger in drought counties than in non-drought counties, indicating drought-induced selection into migration.

Drought's impact on selection into migration, as measured by β_3, can manifest in various ways. For instance, drought might reduce migration for individuals with less than an 8th-grade education while not influencing migration for those with higher education ($\beta_2 < 0$ and $\beta_3 > 0$). Conversely, drought might not impact migration for individuals with less than an 8th-grade education and increase migration for those with higher education ($\beta_2 = 0$ and $\beta_3 > 0$). In both cases, the β_3 values could be the same, but drought's impact on migration for educated individuals is different. To study the effects of drought within education categories, the summation of the β_3 coefficient with the relevant β_2 coefficient is included in results tables.[19]

In terms of controls, the vector of 1935 individual controls (X_{i1935}) includes number of children, and indicator variables for whether the person was male, white, foreign-born, in a city, and birth state. The vector of 1935 county controls (X_{c1935}) includes average age, fraction male, white, in a city, foreign-born and in their birth state, average education in years, population, number of moderate or worse drought years from 1930 to 1934, the distance to the nearest city, and log change in per capita retail sales from 1929 to 1935. Geographic fixed effects are also crucial in controlling for heterogeneity between drought-affected and non-affected counties that individual and county-level controls do not capture. The core results, Table

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drought year is typically for a county over a five-year interval. All results are robust to separating zero and one year of drought into two categories.

[19] For example, the impact of three or more drought years on migration for individuals with a 12th-grade education relative to an individual of the same education in a non-drought county is β_{22} plus β_{34} using the notation from Footnote 19.

4, include models that apply fixed effects for regions, states, state economic areas (SEAs), and counties based on individual locations in 1935.[20] State fixed effects are preferred because they balance comparing similar counties and capture sufficient geographic variability in drought conditions. County fixed effects are also especially interesting as they fully adjust for any pre-existing differences between counties experiencing drought and those not.[21]

VI. Results

[Table 4 here]

Drought increased migration, as shown in column (1) of Table 4. Specifically, residents of counties impacted by drought for two years exhibited a 1.5 percentage point increase in migration likelihood compared to their counterparts in non-drought counties (defined as zero or one year of drought). This propensity increases to 2.0 percentage points for individuals in counties experiencing three or more drought years. These increases represent considerable increments over the baseline migration rate of 11.1 percent observed in non-drought counties. Such findings expand upon prior research (Gutmann, 2016; Hornbeck, 2012; 2023) by directly measuring drought's influence. However, this paper's primary focus and findings lie in showing that the mobility of highly educated individuals predominantly drove the overall increase in migration, a topic explored in the following subsection.

Selection

Migration from drought occurred primarily among individuals with relatively high education, as shown in columns (2) through (8) in Table 4. These columns progressively incorporate controls and fixed

[20] SEAs are groups of counties that share the same characteristics within states. There are roughly 500 SEAs in the United States.

[21] However, because drought varies at the county level, the inclusion of county fixed effects means that I cannot estimate differences in migration rates among the excluded education category with county fixed effects. Because estimating how drought impacted migration for the low education category is helpful for contextualizing selection into migration, and because the interaction terms are very similar using county, SEA, and state fixed effects, I focus on the state fixed effects specifications as the preferred specification.

effects and vary the standard error clustering method within the interaction model.[22] Column (8), the preferred specification, incorporates comprehensive controls at the individual and county levels, along with age and state fixed effects, as elaborated in the Methodology section.

Column (8) panel (a) shows a significant difference in migration based on education levels. Specifically, individuals with a high school education from counties that faced two years of drought were 4.0 percentage points more likely to migrate than those with less than an 8th-grade education from non-drought counties. This likelihood further escalates to 7.2 percentage points for high school-educated individuals in counties enduring three or more drought years, as shown in the last row of panel (a).[23] In contrast, additional drought years did not significantly impact the migration decisions of individuals with less than an 8th-grade education, on average.

It is important to emphasize that the interaction results in Table 4 panel (a) should be interpreted in relation to the omitted group: individuals with less than an 8th-grade education from non-drought counties. These interaction coefficients show that drought was linked to increased positive selection in migration. That is, drought was associated with a higher *proportion* of highly educated migrants. However, the interaction terms alone do not indicate whether drought resulted in higher migration rates among the highly educated.

To quantify the specific impact of drought on migration rates for each education level, the values of the interaction terms are summed with the relevant drought indicators. Panel (b) of Table 4 displays these summations for the preferred specification, showing that drought increased migration rates for highly educated individuals. For example, the last coefficient in panel (b) indicates that three drought years increased migration for highly educated individuals by 6.2 percentage points relative to an observational similar individual in the same education category from a non-drought county within the same state.

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[22] The coefficients, especially on the interaction terms, the terms of primary interest, are relatively stable between specifications.

[23] This additional propensity is in the context of an underlying migration propensity gap of 6.0 percentage points between individuals with a 12th-grade education or higher versus individuals with less than an 8th-grade education.

The results so far have shown that drought influenced migrant selection in general. However, drought impacts could vary significantly across other demographic segments. Sex and urban status are critical dimensions, and exploring these distinctions is essential to understanding whether drought-induced positive selection was a universal phenomenon or isolated to specific population subsets.[24]

[Figure 6 here]

Figure 6 plots the coefficients of the interaction terms disaggregated by sex and 1935 urban status. Drought increased positive selection for married women and men at nearly identical rates for all education levels.[25] To the extent that people married within the same education category (roughly 75 percent), this result indicates that couples were moving together. Couples and families migrating as a unit are indicative of permanent moves and intriguing in light of previous research highlighting the potential for temporary environmental migration (Joarder & Miller, 2013; Kleemans, 2015; Call et al., 2017). Permanent moves, especially in the context of long-distance moves as discussed below, are an essential feature of this migration as the drought region lost population and likely did not recover population in the coming years or decades, as shown in the case of eroded counties (Hornbeck, 2012).

Drought also influenced unmarried men and women's migration, with unmarried women, mainly the highly educated, showing a more pronounced migration response than men. This trend suggests that unmarried women, potentially more vulnerable economically and socially during environmental crises, were more likely to relocate in search of opportunities if they had the economic means. This finding aligns with existing literature on gender differences in environmental migration responses and the role of marital status (Gray & Mueller, 2012a; De Haan et al., 2015) and uniquely contributes by directly comparing environmental migration rates between men and women, explicitly considering marital status in the analysis.

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[24] For the disaggregation, I provide coefficient plots for the regression run separately for each subpopulation for ease of interpretation. I include tables of triple interaction regressions in the Appendix (Tables A3 through A5) to enable discussion of whether differences in migration responses were statistically significant.

[25] Marital status comes from the 1940 census and is a record of marital status in 1940. Therefore, it is an imperfect indicator of marital status for previous years.

Panel (c) of Figure 6 disaggregates the results along the 1935 urban status dimensions. There was a significant difference in the response between low-education urban and rural individuals from three drought years. Low-education rural individuals had a slightly negative response, and urban individuals had a slightly positive response.[26] Additionally, there was a positive migration response from urban and rural locations for higher education categories, especially the high school educated.[27] The robust migration from urban origins specifically is an important finding as the literature focuses on environmental migration from rural and agricultural origins (Cohen et al., 2016; Cattaneo & Peri, 2016; Peri & Sasahara, 2019). However, research documents the widespread impact of environmental shocks (especially heat—a leading factor in drought) on the urban sector (Hsiang, 2010; Dell et al., 2012), particularly in economies without widespread adoption of air conditioners (Barreca et al., 2016). Therefore, it is not entirely surprising that there was also a significant migration response in the urban sector.

Selection mechanism

This section studies why individuals with less education did not move more frequently when faced with persistent drought. Several papers posit that individuals with low human capital or wealth, proxied here with education, are more often constrained in their migration decisions because they do not have the required money or credit to pay the up-front cost of migration (McKenzie & Rapoport, 2010; Cattaneo & Peri, 2016; Bazzi, 2017). This section explores this explanation in the context of the 1930s drought.

The liquidity constraint explanation is consistent with historical evidence of the Dust Bowl. Riney-Kehrberg (1994) surveyed people who stayed in Dust Bowl counties. The most common response to the question of "why did you stay?" was that their family did not have the money to leave or anywhere to go. Although this survey was of people in the Dust Bowl, a similar sentiment likely extended through the

[26] These coefficients are significantly different, as shown in Appendix Table A4.

[27] The gap in urban and rural responsiveness estimated in the coefficients for the excluded group (those with less than an 8th-grade education) carries through the interpretation of the interaction terms so that urban individuals are always more responsive than rural.

broader drought. The 1930s were the decade of the Great Depression, which was long-lasting and severe in drought counties. These conditions likely contributed to difficulties in paying for the cost of migration.

To further examine the role of liquidity and Depression severity, I estimate whether the degree of selection into migration from drought varied based on Depression severity at the origin counties. The hypothesis is that people with lower human capital, more often constrained by liquidity, were less likely to migrate from drought-affected areas, especially from counties severely impacted by the early 1930s economic downturn. To test this hypothesis, I classify counties into two categories (above or below average) based on their Depression severity, using county-level changes in retail sales per capita from 1929 to 1935 derived from Fishback et al. (2006).[28]

[Figure 7 here]

Figure 7 displays the results of splitting the sample between origin counties with lower and higher-than-average economic downturns. The coefficients of all interaction terms are larger from counties with more severe economic downturns, showing that intermediate and positive selection from drought was more pronounced in counties where liquidity constraints were more likely to be binding.[29] This result is consistent with the hypothesis that individuals with lower human capital often lacked the liquidity required to move away from drought.

Sorting

[Table 5 here]

Migration is a decision of whether to leave and where to go, and destination characteristics, as with the decision to leave, likely vary by individual circumstances. This section applies Equation 1's methodology, breaking down the migrant outcome variable into subsets to analyze destination

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[28] This dataset is the standard data for assessing Depression severity in the microeconomics literature. The period from 1929 to 1935 minimizes the overlap with the late 1930s drought conditions while still being directly relevant to financial circumstances in the late 1930s. As shown in Table 3, there is no apparent correlation between the early 1930s Depression severity and the late 1930s drought.

[29] The interaction model is in Appendix Table A5, and the differences between the triple interaction terms for drought, depression, and education are significant for middle and high education from three or more drought years.

characteristics. First, I disaggregate by distance, distinguishing by *county* (intra-state) and *state* (inter-state) *migrants*, as explained below. Second, I disaggregate the destination types: *rural non-farm*, *farm*, and *city*. For each category—distance and destination type—the sum of coefficients for the disaggregated regressions corresponds to the total migration response reported in Table 5, column (8).[30]

To examine migration distances, I define *county migrants* as individuals who moved between counties within the same state and *state migrants* as those relocating outside of their origin state. This approach assesses drought's influence on short- and long-distance migration. The findings in Table 5, columns (1) and (2), reveal that drought was linked to county and state migration among highly educated individuals and predominantly state migration for those with middle education. Notably, the state migration coefficients were larger than the county migration coefficients, a significant observation considering traditional migration patterns tend to favor shorter distances (Bogue & Thompson, 1949; Sjaastad, 1962; Schwartz, 1973; Levy & Wadycki, 1974). This pattern underscores the substantial impact of drought on U.S. population distributions, shifting individuals across state lines more frequently than within counties.

For destination types in terms of rural status, columns (3) through (5) of Table 5 present results for rural non-farm, farm, and city migrants. *Rural non-farm migrants* are those who moved to non-urban areas, *farm migrants* moved to farms, and *urban migrants* relocated to cities (defined as metropolitan areas with roughly 20,000 or more residents). The results show that drought predominantly increased migration to rural non-farm locations. This pattern needs careful interpretation because most migrants were from rural non-farm backgrounds, suggesting that these moves might not have significantly altered the overall rural-urban composition. Although these results control for proximity to cities, origin type (urban or rural), and state fixed effects, it is also important to note the rural nature of drought-affected counties and the tendency for rural residents to relocate within rural areas, even during climatic shocks, as discussed further in the next section.

[30] For example, the summation of the coefficient for two drought years for *county migrant* as the outcome plus the coefficient for two drought years for *state migrant* equal the coefficient for *migrant* as the outcome as reported in Table 4.

Columns (3) through (5) of Table 5 also reveal intriguing patterns for the low education category. Drought conditions resulted in a minor increase in migration to farms for this group, whereas moves to rural non-farm areas and cities declined. This pattern suggests a preference for more economically viable relocations for those with lower educational attainment, like returning to family farms. Despite no substantial change in overall migration rates for this demographic, these findings reveal a notable destination shift among the low-educated group. Finally, it is noteworthy that the strong pattern of drought-induced positive selection does not hold migration to farms specifically, contrasting with trends in rural non-farm and urban relocations.

VII. Discussion

I show that drought heterogeneously influenced migration patterns by individual human capital, expanding migration research by detailing the response to a severe, widespread, and long-lasting shock. My findings are among the first to analyze environmental migrant selection and sorting at the individual level (Gray & Mueller, 2012a; Sedova & Kalkuhl, 2020). Understanding who moves is crucial for grasping the full implications of environmental shocks and effectively allocating relief resources (Hunter et al., 2015; Wiegel & Jentsch, 2019). Studies focusing on migration using geographic averages (county- or country-level, for example) risk the ecological fallacy (Piantadosi et al., 1988), where migration from more affluent areas does not imply it is the affluent who are moving. I show that the 1930s drought increased the proportion and number of highly educated migrants: a scenario of unequal opportunity where the more educated disproportionately left, and the less educated stayed. This suggests, to the extent that education correlates with wealth and affluence, that those who remained were likely among the most vulnerable to decreased living standards.

The impact of drought on migration patterns was extensive, affecting women and men from urban and rural backgrounds. My research expands the historical focus on men in migration studies (Pedraza, 1991; Nawyn, 2010), particularly in economic history, which often excludes women from the analysis due to reliance on linked census data (Ruggles et al., 2018). Sex-specific responses are critical when studying environmental degradation because attitudes and responses depend on societal roles, responsibilities, and risks that vary by sex (Chindarkar, 2012; Gray & Mueller, 2012b; Cattaneo et al., 2019). I find that married couples tended to migrate together, while unmarried women showed higher response rates than men, contributing to the debate on migration responses by sex to environmental shocks (Dillon et al., 2011; Gray & Mueller, 2012a; Mueller et al., 2014; Thiede et al., 2016; Baez et al., 2017). My findings highlight the necessity of contextualizing economic history and environmental migration research focused on men as potentially not reflecting the experiences and patterns of women. Future studies should avoid generalizing results based on male data as representative of the whole population and should strive to differentiate between the experiences of men and women, particularly for the unmarried.

My results highlight the need to consider rural and urban origins in environmental migration studies. Much of the existing literature focuses on the rural flow of migrants or does not separate the migration response by urban and rural origins (Peri & Sasahara, 2019; Cattaneo & Peri, 2016; Cohen, 2016; Millock, 2015). During the 1930s, people left drought-stricken areas in both settings. The migration from urban areas, potentially driven by the drought's relation to heat, highlights the multifaceted impact of drought, affecting not just agriculture but also human health and industrial production (Deschênes & Moretti, 2009; Hsiang, 2010; Dell et al., 2012; Barreca et al., 2016). Furthermore, it is essential to document this urban out-migration to contextualize migrant destinations, as cities experiencing drought-related out-migration are unlikely sanctuaries for other people displaced by drought.

The strong pattern of environmentally-induced positive selection held for the population as a whole and each of the subsets investigated. Historical testimony and empirical evidence suggest that the lack of immediate funds limited drought-related migration for less-educated or less-affluent individuals. This finding aligns with broader literature highlighting the importance of financial liquidity for environmental migration (Cattaneo & Peri, 2016; Bazzi, 2017). Nevertheless, the most closely related literature on environmental migration at the individual level shows that shocks may also induce less positive selection

(Sedova & Kalkuhl, 2020). The contrast between my findings and related studies indicates that the nature of the environmental shock—its duration, severity, and type—influences environmental migrant selection as well as individual and average characteristics of the affected population, such as wealth, transportation access, external employment opportunities, and property ownership. This variation suggests the need for further research to pinpoint the crucial factors driving individual responses to different types of environmental shocks in various circumstances.

With respect to migrant destinations, my finding that drought migrants tended to move across state lines is important because migration tends to be short-distance, and long-distance migration has a larger economic impact on the migrants and the broader economy (Levy & Wadycki, 1974; Schwartz, 1973; Sjaastad, 1962; Bogue & Thompson, 1949). The late 1930s saw a significant depopulation of the Great Plains, with drought and long-distance migration as key contributors. Drought-induced migrants primarily moved to rural non-farm areas or urban locations. This result is consistent with Cattaneo and Robinson (2020), highlighting the importance of rural-to-rural for internal migration. However, it diverges from prior research emphasizing urban migration in response to climate events (Cohen, 2016; Adger et al., 2015; Barrios et al., 2005). The 1930s were marked by the Great Depression, which hit metropolitan areas first and, likely, hardest, leading to a back-to-the-land movement from cities to smaller towns and rural areas (Todara, 1969; Boyd, 2002). Additionally, cities in the drought region (dependent on agricultural output and heat-stricken) were potentially dubious destinations for displaced rural residents. While urban areas were particularly unappealing during the 1930s, local cities often may be unlikely to be the default destination for environmental migrants, and we should question research that assumes this relationship without empirical evidence. This insight is especially true in cases where the affected population originally comes from non-urban areas and may have many lifestyle preferences aligning with rural life.

Beyond the broad environmental migration literature, this paper also specifically contributes to the 1930s U.S. environmental migration literature. As I discuss in Section II, this migration period has been a focus of scholarly attention for nearly a century. Hornbeck (2023) recently provided valuable insights into migration patterns from soil erosion across the Great Plains. Both Hornbeck's study and mine broaden the traditional geographic and conceptual scope of 1930s environmental migration research, offering new perspectives on the causes and impacts of such migrations. Despite some overlap, the unique aspects of our papers—especially my focus on drought versus Hornbeck's focus on soil erosion and our different empirical approaches to studying migrant selection—offer fruitful avenues for comparison and analysis.

While drought and erosion may intersect, they are fundamentally different environmental shocks.[31] Erosion, the displacement of topsoil by wind or water, poses a long-term challenge to agriculture, requiring years or even decades for soil recovery. In contrast, the impacts of drought—characterized by reduced precipitation and increased heat—tend to be more transient, often alleviating once normal weather patterns resume. Moreover, while erosion primarily affects agriculture, drought has broader implications, impacting both agricultural and urban areas due to its association with heat. Understanding these distinctions is crucial, as they suggest differing migration responses and selection patterns in the face of these different environmental shocks.

The question of migrant selection is critically important, bearing significant economic implications and being key to assessing the benefits of migration. Despite its importance, migrant selection in the 1930s has been underexplored, and few other periods or contexts provide sufficient data to investigate selection questions thoroughly. My research focuses on how drought influenced migration propensities, using education level to understand who was more likely to move. By contrast, Hornbeck (2023) examines how erosion affected the level of education for the average migrant and finds that migrants from more eroded counties tended to have less education, shedding light on the shifting characteristics of migrants due to erosion. It is crucial to note that Hornbeck's findings do not suggest that erosion predominantly prompted migration among the less educated, nor do my findings suggest that the average migrant from drought-

[31] Drought can be a factor in erosion (especially wind erosion). However, other environmental factors also impact erosion (flooding is especially important), and erosion is endogenous to the intensity and technique of agricultural activity. In the 1930s, drought, and erosion had different geographic ranges and reached their greatest intensity in different areas. On the Great Plains, the worst erosion was south and east of the worst drought, and for the nation, the worst erosion was probably in the south, while the worst drought was on the Northern Plains, Mountain West, and Northwest.

affected areas was necessarily more educated. That is, Hornbeck and my research answer two fundamentally different questions concerning migrant selection. Such nuanced distinctions and qualifying the reach of selection results are incredibly important for documenting and understanding migrant selection and its implications.

The specific characteristics of shocks and the populations they impact are vital to understanding environmental migration. The literature is evolving from estimating the number of migrants to detailing their economic characteristics, raising questions about differential demographic responses across time and place. Comprehensive analyses of each shock and its impact on affected populations, coupled with careful consideration of econometric methodology and its nuanced implications, facilitate a deeper and more complete view of environmental migration.

VIII. Conclusion

In light of the severity, length, and spatial expanse of the 1930s drought, we know little about the drought's economic consequences. Compared to most weather and climate shocks, this was a prolonged and widespread shock that impacted an ecologically and economically diverse country. I study who moved and where migrants went in scale and detail that is impossible for most other times and places. My results contribute to our understanding of migration and settlement in U.S. history, the geographic human capital implications of environmental shocks, and provide perspective on the likely consequences of modern shocks.

Previous environmental-migration research focuses on the aggregate flows of migrants. This emphasis stems from the need for more comprehensive data on individuals pre- and post-migration. It introduces questions concerning why people move from specific shocks but not others and whether environmental migrants differ from other migrants. I show widespread drought did not uniformly increase migration across the education spectrum. Instead, drought increased migration for the highly educated, indicating that migration was an adaptation method adopted primarily by affluent individuals and families.

This result was true for women and men from rural and urban locations and is essential to understanding who bears the costs of shocks and their lasting consequences.

Studying migrant destinations in terms of distance and rural and urban status stresses the importance of considering shock characteristics and the circumstances of the impacted population. Most migrants from drought counties moved across state lines. These long-distance moves were relatively uncommon and were part of the reason the drought was so impactful—people left the area rather than relocate nearby. Most migrants moved to rural destinations, suggesting that the extent of urbanization resulting from climate shocks relies on the details of the shocks, the integration of local metropolitan areas with the agricultural sector, the vibrancy of employment in other sectors, more distant options, and individual preferences for urban or rural locations.

The frontier of climate migration research employs individual-level data that enable the heterogeneous study of migrant attributes and destinations. As research progresses, we begin to answer questions concerning migrant selection and sorting under specific conditions. My research builds an intricate and comprehensive view of a particularly influential episode: who utilized migration as adaptation and how these migrants reshaped the geographic human capital distribution of the United States.

Online Appendix

[Table A1 here]

[Table A2 here]

Triple interaction models: drought, education, and variable of interest

Figures 6 and 7 report the results of estimating changes in migration propensity distinguishing by demographics of interests: *sex*, *1935 urban status*, and *Depression severity*. The regressions underlying Figures 6 and 7 use Equation 1 with the sample differentiated by the variable of interest. While this approach offers transparent and interpretable results, it does not formally analyze the statistical differences in migration responses across these demographic variables.

Equation A1 is a triple interaction model that estimates the same relationships as displayed in Figures 6 and 7 and enables the examination of the statistical significance of differences.

(A1) $M_i = \alpha + \beta_1 E_i + \beta_2 D_c + \beta_3 V_i + \beta_3 (D_c \times E_i) + \beta_4 (V_i \times E_i) + \beta_5 (D_c \times V_i)$
$+ \beta_6 (D_c \times E_i \times V_i) + (\theta_1 X_{i1935} + \theta_2 X_{c1935} + \gamma_{s1935} + \gamma_a) \times V_c + \varepsilon_i$

Equation A1 mirrors Equation 1's structure and controls and incorporates additional interaction terms. These terms facilitate the examination of the combined effects of drought, education, and another variable of interest. The baseline category comprises individuals with less than an 8th-grade education from non-drought counties who do not meet the specific variable condition. The equation includes vectors for drought and education $(D_c \times E_i)$, education and variable of interest interactions $(V_i \times E_i)$, and for drought and variable of interest interactions $(D_c \times V_i)$. It also features a triple interaction vector $(D_c \times E_i \times V_i)$ to assess the interplay among drought status, education level, and the variable of interest. Finally, all other controls and fixed effects are interacted with the variable of interest so that the estimated coefficients are the same as those estimated with the split sample in the main text.

Tables A3 through A5 report the results of estimating Equation A1. The main text references these tables and coefficients when distinguishing that a particular difference in migration response was statistically significant.

[Table A3 here]

[Table A4 here]

[Table A5 here]

Alternate drought measure

The *number of moderate or worse drought years* variable used in this paper as a straightforward measure of drought exposure over multiple years using established yearly definitions of drought. Nevertheless, there are other ways to measure drought over multiple years. Another measure is to sum the total index value of drought each county experienced over the five years.

Equation A2 defines a measure of total drought over five-year periods for county *c*.

(A2) $Total\ drought_c = -(\sum_{y=1935}^{1939} drought\ severity_{cy}\ |\ drought\ severity_{cy} < 0)$

Given this measure of total drought over five-year periods, I then create a series of indicator variables for drought severity in A3:

$$\text{(A3)} \quad \begin{aligned} Normal\ conditions_c &= 1\ if\ total\ drought_c < 5 \\ Mild\ drought_c &= 1\ if\ 5 <= total\ drought_c < 8 \\ Moderate\ drought_c &= 1\ if\ 8 <= total\ drought_c < 11 \\ Severe\ drought_c &= 1\ if\ 11 <= total\ drought_c \end{aligned}$$

Normal conditions constitute the equivalent of mild drought or less for all five years, for example. Each subsequent category is defined by adding roughly one standard deviation (value of three) in the total drought index value for the five years. As in the main text, I include *mild drought* with *normal conditions* as the excluded category, and all results are robust to separating mild drought. Tables A6 and A7 recreate the primary selection and sorting results using the alternate measure of drought exposure. When total drought is used instead of the number of drought years, the results are similar, mostly larger, and more significant.

[Table A6 here]

[Table A7 here]

Considerations in using full count versus linked census data

The 1940 census offers unparalleled data detail and scale. An alternative method is to use linked census data to incorporate additional controls and pre-trends. However, given the limitations in the linkage process and this paper's focus on migrant selection, using linked census data would fundamentally weaken the paper. Considerations are detailed below.

Conservative linking methods, such as those employed by the Census Linkage Project, present a false linkage rate of approximately 10 percent (Abramitzky et al., 2020). While this rate is acceptable for some studies, it poses a significant challenge for migration research, especially migrant selection research. To illustrate, if the true migration rate between counties from 1930 to 1935 was 10 percent and 10 percent of the records were incorrectly linked, the observed migration rate would misleadingly double to 20 percent. Such discrepancies are further complicated in selection studies, where socio-economic characteristics may affect the likelihood of incorrect linkages, rendering early 1930s migrant selection data unreliable.

Selection into linkage is also a problem, as the likelihood of being linked between the two censuses depends on socio-economic variables such as education, with more highly educated people more often linked because they were more likely to spell their names and report their age consistently. While some studies can circumvent the problem, it remains a challenge in migration research (Zimran, 2023), particularly when studying migrant selection. Furthermore, I would have linked census data for migration from 1930 to 1935 and observed migration perfectly from 1935 to 1940; therefore, comparing the selection between the two periods would be inappropriate. Moreover, the onset of the drought in the early 1930s and the significant migration that began in 1934 complicate the use of 1930 to 1940 linked census data for establishing pre-drought migration trends. A comprehensive analysis would require a triennial link across the 1920, 1930, and 1940 censuses to construct a viable difference-in-differences model. This approach, however, is hampered by the outlined issues of false linkages and selection biases, which are further magnified when linking across three census periods. Adding to these difficulties, the 1940 census marks the first instance of education recording, making a comparative selection study starting in 1920 or 1930 (perhaps based on occupation) a fundamentally different investigation.

Finally, it is important to note that most census linkage is conducted only for men. Including women and distinguishing between migration by sex and marital status are important contributions to environmental migration literature. Given these challenges, the exact and full coverage of the 1935 to 1940 migration data is the most reliable and accurate foundation for this study, enabling a solid analysis of migration patterns.

During the preparation of this work, the author used ChatGPT4 to improve the flow and readability of certain paragraphs. After using this tool/service, the author reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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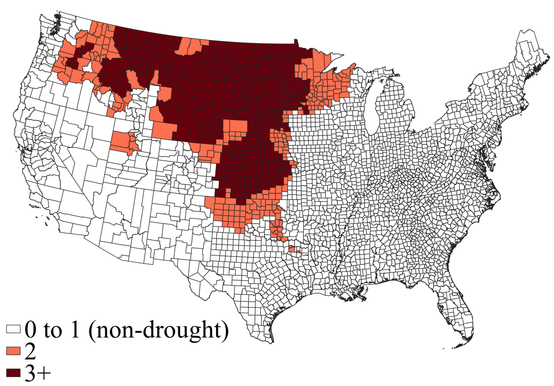
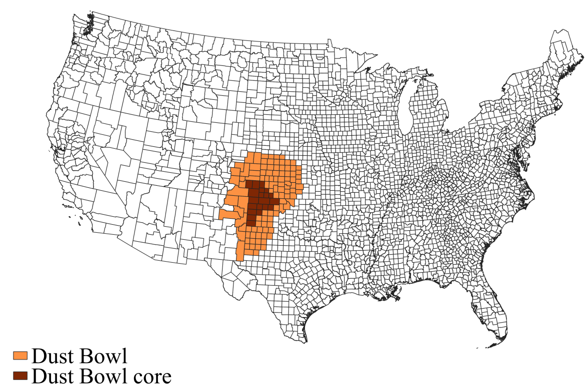
Figures and tables

Figure 1: Drought and the Dust Bowl

(a) Drought years from 1935 to 1939

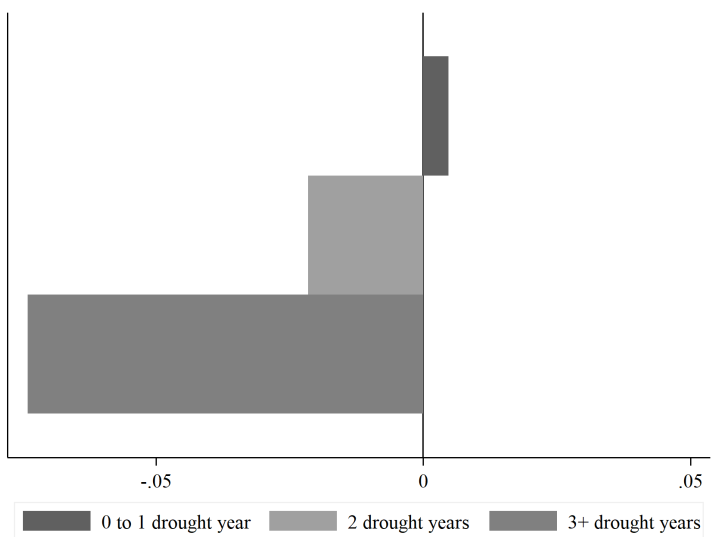


(b) Dust Bowl



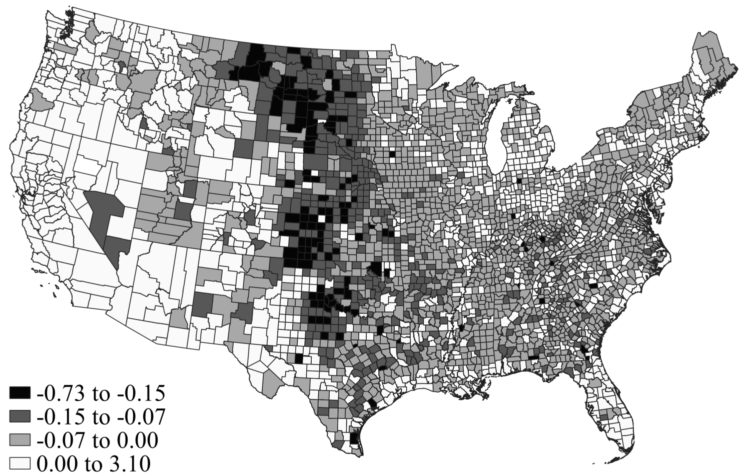
Notes: Panel (a) shows the number of drought years from 1935 to 1939, with darker red indicating more drought. Panel (b) outlines definitions of *the Dust Bowl*. The larger set of counties outlined are the largest defined by the U.S. Department of Agriculture as counties severely impacted by wind erosion during the 1930s (Natural Resources Conservation Service 2012).

Figure 2: Net migration from 1935 to 1940 by drought years from 1935 to 1939



Notes: The figure illustrates county-level net migration (the difference between the number of people who left and those who entered, divided by the county's population in 1935) categorized by drought years. Counties with zero or one drought year experienced a slight increase in population through migration. By contrast, counties with two or more years of drought saw population losses of 2.0 and 7.2 percent due to migration. The relatively minor impact on non-drought county populations is attributed to the larger population size and greater number of non-drought counties despite significant outflows from drought-affected counties.

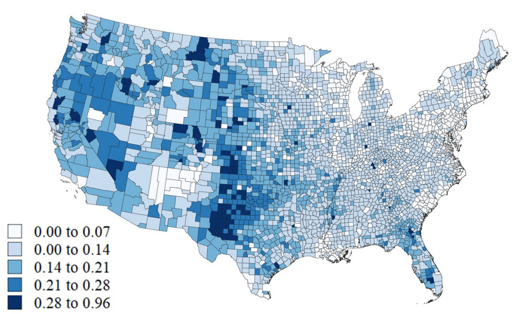
Figure 3: Net migration from 1935 to 1940



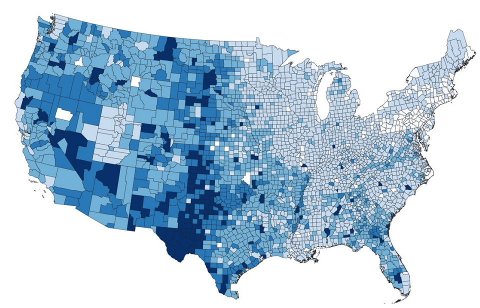
Notes: This figure shows net migration by county as a fraction of 1935 population and indicates a depopulation throughout the Great Plains. This depopulation, especially in the Northern Plains, overlapped with drought.

Figure 4: Fraction of 1935 population to have left by 1940

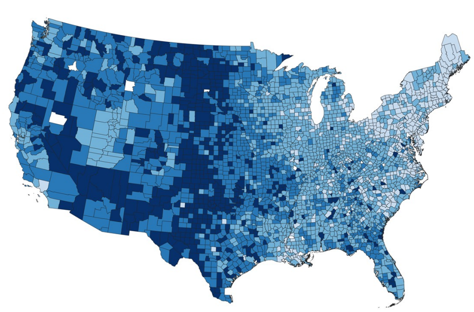
(a) < 8th grade



(b) 8th to 11th grade



(c) > 11th grade



Notes: This figure illustrates out-migration patterns, differentiated by education level. While the geographic pattern of out-migration is consistent across educational categories, the intensity varies. The data show an increase in migration frequency, indicated by darker shades in the figure, with higher levels of education, suggesting a trend of positive selection into migration. This trend is observable irrespective of the specific influence of drought conditions.

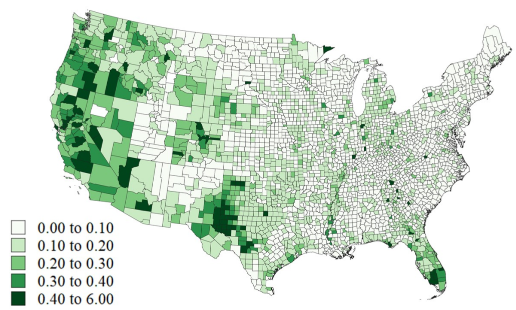
Table 1: Population and migrants by drought years

Drought years	0 to 1	2	3+
Population			
1935 adult population (age 18 to 65)	64,413,486	3,208,280	2,486,785
1935 to 1940 migrants	7,230,044	565,120	511,992
Migrants as percent of their population			
All migrants	11.1	17.3	19.9
Female migrants	10.5	16.8	20.0
Male migrants	11.6	17.7	19.9
Migrants from urban areas	12.8	18.8	19.7
Migrants from rural areas	9.5	15.0	20.9

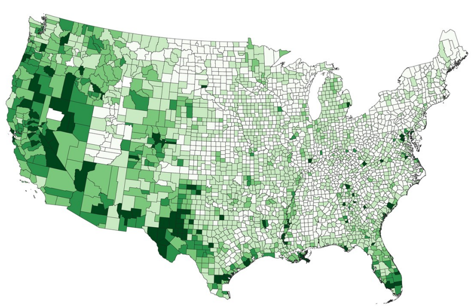
Notes: This table presents individual-level populations and migration rates for various subpopulations: women and men and those in urban and rural locations as of 1935. For subgroups, the *percent migrant* statistics are relative to that subgroup's population. For example, the percentage of female migrants is relative to the entire female population. The basic pattern across all subgroups is consistent: migration rates approximately doubled between counties experiencing zero or one drought year and those with three or more.

Figure 5: New residents entered by 1940 as a fraction of 1935 population

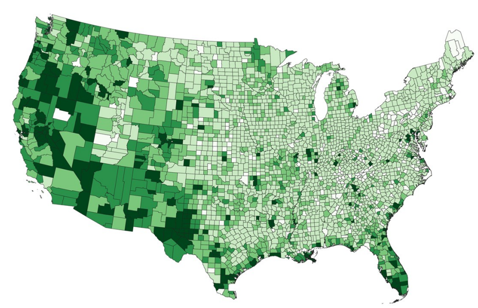
(a) < 8th grade



(b) 8th to 11th grade



(c) > 11th grade



Notes: This figure presents in-migration trends differentiated by education level. The in-migration pattern remains relatively consistent geographically across various educational backgrounds. The majority of migrants relocated to counties in the western United States. Similar to the out-migration trends observed in Figure 4, the data shows an increase in migration frequency with higher levels of education, indicated by darker shades.

Table 2: Migrants by destination: percents of population

Drought Years	0 to 1	2	3+
Migrant distance			
County migrant (intra-state)	6.4	8.5	9.3
State migrant (inter-state)	4.6	8.8	10.7
Migrant type			
Rural (non-farm) migrant	4.5	7.2	8.7
Farm migrant	1.9	3.4	5.1
Urban migrant	4.5	6.7	6.1

Notes: This table details the migrant variable by destination characteristics, distinguishing between county and out-of-state migrants and urban, rural non-farm, and farm migrants. The sum of disaggregated migrant categories equals the total percentage of migrants, accounting for rounding errors. In counties with zero or one drought year, most migrants stayed within the state. Out-of-state migration was more common in areas with three or more years of drought. The data also indicates urban and rural non-farm destinations were most popular from non-drought counties, with an increase in rural non-farm and farm locations correlating with more drought years.

Table 3: 1935 county demographics by drought years

Drought years	0 to 1	2	3+
Demographics: 1935 percent			
Urban	53.1	38.9	15.9
White	90.2	98.1	98.7
Male	50.1	51.3	51.5
In birth state	61.9	51.5	53.5
Foreign born	14.1	11.3	10.4
County acres in farming	63.3	71.3	81.5
Demographics: 1935 average			
Age	42.7	43.0	43.1
Education (in years)	8.4	9.2	9.0
Great Depression			
Percent growth in retail spending (1929 to 1935)	-22.6	-22.8	-22.0
Percent growth in retail spending (1929 to 1939)	0.2	-6.9	-12.8
Per capita public works and relief spending 1933 to 1939 (1935 dollars)	$101	$120	$139
Per capita AAA spending 1933 to 1937	$37	$134	$191

Notes: Drought counties were less urban and had a higher portion of their population was white and born outside of the state.

Table 4: Migration response to drought years by education attainment

	(1) Migrant	(2) Migrant	(3) Migrant	(4) Migrant	(5) Migrant	(6) Migrant	(7) Migrant	(8) Migrant
Panel a: Drought and interaction coefficients								
2 drought years	0.015***	0.040*	0.008	-0.005		-0.019**	-0.002	-0.002
	(0.004)	(0.021)	(0.007)	(0.007)		(0.007)	(0.005)	(0.007)
3+ drought years	0.020***	0.046***	-0.003	-0.016**		-0.026***	-0.010	-0.010
	(0.006)	(0.014)	(0.010)	(0.008)		(0.007)	(0.007)	(0.007)
(2 drought years)x(8th to 11th)		0.014	0.014**	0.007	0.014*	0.013*	0.011*	0.011*
		(0.009)	(0.007)	(0.007)	(0.007)	(0.007)	(0.005)	(0.006)
(3+ drought years)x(8th to 11th)		0.034***	0.026***	0.022***	0.027***	0.022***	0.020***	0.020***
		(0.004)	(0.005)	(0.005)	(0.007)	(0.005)	(0.005)	(0.005)
(2 drought years)x(> 11th)		0.039***	0.048***	0.037***	0.042***	0.040***	0.040***	0.040***
		(0.013)	(0.011)	(0.011)	(0.011)	(0.011)	(0.009)	(0.010)
(3+ drought years)x(> 11th)		0.085***	0.085***	0.077***	0.077***	0.073***	0.072***	0.072***
		(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.010)	(0.009)
Panel b: Migration responses relative to individuals within the same education category								
8th to 11th from 2 drought years								0.009**
								(0.004)
8th to 11th from 3+ drought years								0.010
								(0.007)
> 11th from 2 drought years								0.038***
								(0.005)
> 11th from 3+ drought years								0.062***
								(0.008)
Observations	69,654,324	69,654,324	69,654,324	69,654,324	69,654,324	69,654,324	69,654,084	69,654,324
Controls	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	State and age	No	No	Region and age	County and age	SEA and age	State and age	State and age
Clustered standard errors	State	State	State	State	State	State	Conley	State

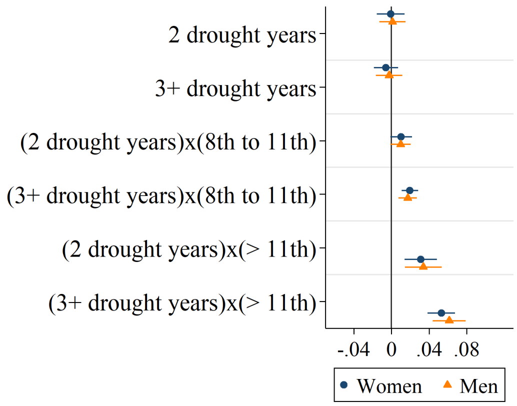
Standard errors clustered by 1935 state in parentheses

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

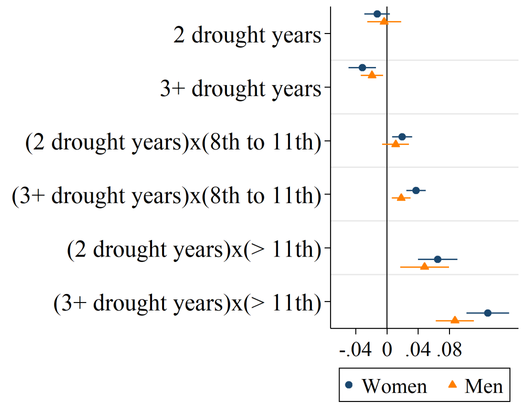
Notes: These are the results of estimating Equation 1. Column (1) does not include the interaction terms to show that drought increased migration overall. Columns (2) through (8) show the results of the interaction regression varying the controls, fixed effects, and standard error clustering. Column (8) is the preferred specification, using individual and county controls, state and age fixed effects, and clustered standard errors at the state level. Panel (b) sums the drought and relevant interaction coefficient to show how migration changed within each education category. For example, the last coefficient is the sum of the coefficient for three or more drought years and the interaction between three drought years and an 11th-grade education.

Figure 6: Migration response to drought years by demographic subgroups

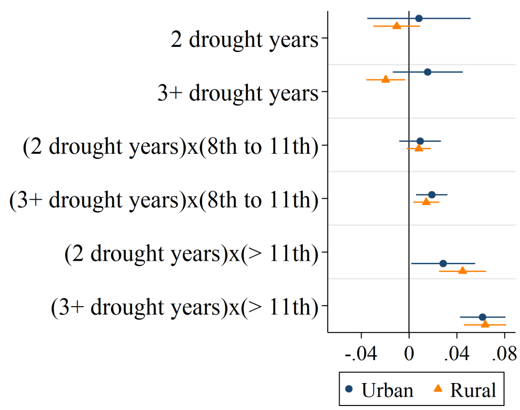
(a) Married



(b) Unmarried

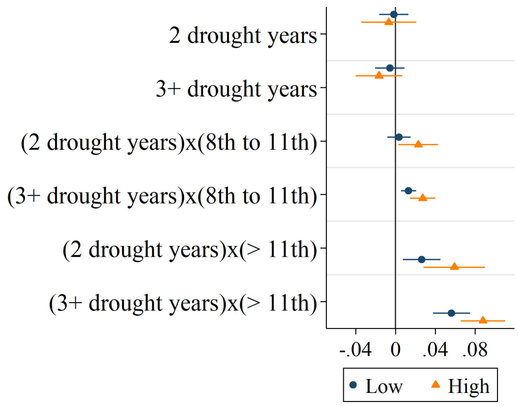


(c) Urban and rural origins



Notes: This figure presents results from subdividing Equation 1's sample into key subgroups: women and men and individuals from urban and rural backgrounds. Panel (a) shows similar migration rates for married women and men. However, as shown in panel (b) and Appendix Table A3, highly educated unmarried women exhibited significantly higher mobility in response to drought than men. Panel (c) shows migration from urban and rural areas in response to drought.

Figure 7: Selection into migration by below and above average Depression severity



Notes: These results are distinguished by Depression severity measured in 1935. Depression severity may have further constrained individual liquidity. The results of more positive selection from counties with worse Depression severity are consistent with the hypothesis that liquidity played a role in the increased positive selection into migration resulting from drought.

Table 5: Migration by destination type

	(1) State migrant (Inter-state)	(2) County migrant (Intra-state)	(3) Rural (non-farm) migrant	(4) Farm migrant	(5) Urban migrant
2 drought years	-0.002	0.000	-0.001	0.004	-0.005
	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)
3+ drought years	-0.009	-0.001	-0.007*	0.007*	-0.010**
	(0.005)	(0.006)	(0.004)	(0.004)	(0.005)
(2 drought years)x(8th to 11th)	0.009**	0.002	0.004	0.002	0.004
	(0.004)	(0.002)	(0.003)	(0.003)	(0.003)
(3+ drought years)x(8th to 11th)	0.016***	0.004	0.010***	0.008***	0.002
	(0.005)	(0.003)	(0.002)	(0.002)	(0.003)
(2 drought years)x(> 11th)	0.027***	0.013**	0.019***	-0.005	0.026***
	(0.008)	(0.005)	(0.006)	(0.005)	(0.007)
(3+ drought years)x(> 11th)	0.043***	0.030***	0.046***	-0.003	0.029***
	(0.010)	(0.006)	(0.005)	(0.003)	(0.005)
8th to 11th from 2 drought years	0.007*	0.002	0.004	0.006***	-0.001
	(0.004)	(0.004)	(0.003)	(0.002)	(0.003)
8th to 11th from 3+ drought years	0.008	0.002	0.003	0.015***	-0.008**
	(0.005)	(0.006)	(0.004)	(0.004)	(0.004)
> 11th from 2 drought years	0.025***	0.013**	0.019***	-0.001	0.021***
	(0.006)	(0.005)	(0.003)	(0.003)	(0.004)
> 11th from 3+ drought years	0.034***	0.028***	0.039***	0.004	0.018***
	(0.008)	(0.007)	(0.005)	(0.003)	(0.005)
Observations	69,654,324	69,654,324	69,654,324	69,654,324	69,654,324

Standard errors in parentheses

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

Notes: This table presents the sorting analysis, categorizing migrants based on their relocation to within or outside their origin state, columns (1) and (2), and their move to rural non-farm, farm, or urban locations, columns (3) through (5). The data indicates that drought led mostly to out-of-state migration for highly educated individuals. As detailed in columns (4) and (5), the pattern and rate of migration to farm locations exhibit unique trends differing from the overall sample, warranting further discussion in the text.

Online Appendix Tables

Table A1: Table 4 with full controls displayed

	(1) Migrant	(2) Migrant	(3) Migrant	(4) Migrant	(5) Migrant	(6) Migrant	(7) Migrant	(8) Migrant
8th to 11th grade ed.	0.012***	0.017***	0.021***	0.011***	0.011***	0.011***	0.011***	0.011***
	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
> 11th grade ed.	0.065***	0.086***	0.080***	0.060***	0.060***	0.060***	0.060***	0.060***
	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
2 drought years	0.015***	0.040*	0.008	-0.005		-0.019**	-0.002	-0.002
	(0.004)	(0.021)	(0.007)	(0.007)		(0.007)	(0.005)	(0.007)
3+ drought years	0.020***	0.046***	-0.003	-0.016**		-0.026***	-0.010	-0.010
	(0.006)	(0.014)	(0.010)	(0.008)		(0.007)	(0.007)	(0.007)
Number of children	-0.009***		-0.012***	-0.009***	-0.009***	-0.009***	-0.009***	-0.009***
	(0.001)		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
In birth state	-0.068***		-0.057***	-0.068***	-0.068***	-0.068***	-0.068***	-0.068***
	(0.003)		(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Male	0.010***		0.010***	0.010***	0.010***	0.010***	0.010***	0.010***
	(0.001)		(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
White	0.046***		0.038***	0.047***	0.047***	0.047***	0.047***	0.047***
	(0.003)		(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)
In city	-0.007		-0.006	-0.007	-0.007	-0.007	-0.007	-0.007
	(0.007)		(0.007)	(0.007)	(0.007)	(0.007)	(0.010)	(0.007)
Foreign born	-0.044***		-0.055***	-0.044***	-0.045***	-0.045***	-0.044***	-0.044***
	(0.003)		(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)
Average age in county	-0.000		-0.007*	-0.001		-0.003	-0.000	-0.000
	(0.002)		(0.004)	(0.002)		(0.003)	(0.002)	(0.002)
Fraction male in county	0.686***		0.434	0.539**		0.598***	0.694***	0.694***
	(0.160)		(0.260)	(0.229)		(0.105)	(0.146)	(0.157)
Fraction white in county	-0.031		-0.042*	-0.041*		-0.024	-0.032	-0.032
	(0.021)		(0.024)	(0.022)		(0.016)	(0.018)	(0.021)
Fraction urban in county	-0.005		-0.023*	-0.017		0.008	-0.005	-0.005
	(0.012)		(0.013)	(0.013)		(0.011)	(0.015)	(0.012)
Fraction in birth state in county	0.050**		-0.041	0.011		-0.026	0.050**	0.050**
	(0.023)		(0.027)	(0.024)		(0.017)	(0.023)	(0.023)
Average education in county	0.004		0.001	0.005		-0.001	0.004	0.004
	(0.003)		(0.004)	(0.004)		(0.003)	(0.003)	(0.003)
Fraction foreign born in county	-0.087***		-0.212***	-0.115***		-0.176***	-0.086***	-0.086***
	(0.031)		(0.042)	(0.039)		(0.031)	(0.035)	(0.031)
2 drought years in early 1930s	0.010		-0.001	0.007		0.003	0.010	0.010
	(0.008)		(0.008)	(0.009)		(0.006)	(0.007)	(0.008)
3+ drought years in early 1930s	0.014*		-0.003	0.008		0.009	0.014*	0.014*
	(0.007)		(0.009)	(0.008)		(0.006)	(0.007)	(0.007)
Miles to nearest city	0.000***		0.000***	0.000***		0.000***	0.000***	0.000***
	(0.000)		(0.000)	(0.000)		(0.000)	(0.000)	(0.000)
Growth in retail sales 1929 to 1935	0.013		-0.020*	-0.013		0.009	0.013	0.013
	(0.008)		(0.011)	(0.011)		(0.009)	(0.008)	(0.008)
(2 drought years)x(8th to 11th)		0.014	0.014**	0.007	0.014*	0.013*	0.011*	0.011*
		(0.009)	(0.007)	(0.007)	(0.007)	(0.007)	(0.005)	(0.006)
(3+ drought years)x(8th to 11th)		0.034***	0.026***	0.022***	0.027***	0.022***	0.020***	0.020***
		(0.004)	(0.005)	(0.005)	(0.007)	(0.005)	(0.005)	(0.005)
(2 drought years)x(> 11th)		0.039***	0.048***	0.037***	0.042***	0.040***	0.040***	0.040***
		(0.013)	(0.011)	(0.011)	(0.011)	(0.011)	(0.009)	(0.010)
(3+ drought years)x(> 11th)		0.085***	0.085***	0.077***	0.077***	0.073***	0.072***	0.072***
		(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.010)	(0.009)
Observations	69,654,324	69,654,324	69,654,324	69,654,324	69,654,324	69,654,324	69,654,084	69,654,324
Controls	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	State and age	No	No	Region and age	County and age	SEA and age	State and age	State and age
Clustered standard errors	State	State	State	State	State	State	Conley	State

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: These are the results of Table 4 with all controls included for reference.

Table A2: Robustness for Table 4: Logit

	(1) Migrant	(2) Migrant	(3) Migrant	(4) Migrant	(5) Migrant	(6) Migrant	(7) Migrant
2 drought years	0.095***	0.438**	0.138**	0.085		0.030	0.087**
	(0.028)	(0.203)	(0.066)	(0.065)		(0.045)	(0.041)
3+ drought years	0.126***	0.497***	0.108	0.046		0.089*	0.067
	(0.040)	(0.147)	(0.099)	(0.076)		(0.052)	(0.054)
(2 drought years)x(8th to 11th)		0.055	0.050	-0.033	0.015	0.004	-0.007
		(0.082)	(0.050)	(0.049)	(0.053)	(0.049)	(0.045)
(3+ drought years)x(8th to 11th)		0.188***	0.104***	0.047	0.084**	0.048	0.039
		(0.050)	(0.036)	(0.032)	(0.042)	(0.030)	(0.030)
(2 drought years)x(> 11th)		0.038	0.126	-0.000	0.036	0.023	0.027
		(0.111)	(0.084)	(0.073)	(0.078)	(0.076)	(0.075)
(3+ drought years)x(> 11th)		0.244***	0.231***	0.134*	0.143**	0.114*	0.110*
		(0.093)	(0.073)	(0.075)	(0.062)	(0.064)	(0.064)
Observations	69,654,324	69,654,324	69,654,324	69,654,324	69,630,466	69,654,084	69,654,324
Controls	Yes	No	Yes	Yes	Yes	Yes	Yes
Fixed effects	State and age	No	No	Region and age	County and age	SEA and age	State and age
Clustered standard errors	State	State	State	State	State	State	State

Standard errors clustered by 1935 state in parentheses

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

Notes: These are the results of estimating Equation 1 as a logit model. Column (1) does not include the interaction terms to show that drought increased migration overall. Columns (2) through (7) show the results of the interaction regression varying the controls, fixed effects, and standard error clustering. The results are the same signed and significant, indicating that the main results of this paper are robust to a logit specification.

Table A3: Triple interaction for Figure 6 panel (a) and (b): married and unmarried women and men

	(1) Migrant (Married)	(2) Migrant (Unmarried)
2 drought years	−0.001	−0.012
	(0.007)	(0.008)
3+ drought years	−0.006	−0.031***
	(0.006)	(0.009)
(2 drought years)x(8th to 11th)	0.010*	0.019***
	(0.006)	(0.006)
(3+ drought years)x(8th to 11th)	0.020***	0.038***
	(0.004)	(0.006)
(2 drought years)x(> 11th)	0.031***	0.065***
	(0.009)	(0.013)
(3+ drought years)x(> 11th)	0.053***	0.129***
	(0.007)	(0.014)
(2 drought years)x(Male)	0.002	0.009
	(0.001)	(0.007)
(3+ drought years)x(Male)	0.003**	0.012*
	(0.002)	(0.006)
(2 drought years)x(8th to 11th)x(Male)	−0.001	−0.008
	(0.001)	(0.005)
(3+ drought years)x(8th to 11th)x(Male)	−0.002	−0.019***
	(0.001)	(0.004)
(2 drought years)x(> 11th)x(Male)	0.003	−0.017**
	(0.004)	(0.007)
(3+ drought years)x(> 11th)x(Male)	0.008***	−0.042***
	(0.003)	(0.010)
Observations	51,873,918	17,780,166

Standard errors clustered by 1935 state in parentheses

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

Notes: This table provides interaction results to evaluate the statistical significance of coefficient differences. The regressions include age and state fixed effects and individual and county controls as discussed in the context of Equation 1 and A1.

Table A4: Triple interaction for Figure 6 panel (c): urban and rural origins

	(1)
	Migrant
2 drought years	−0.010
	(0.010)
3+ drought years	−0.020**
	(0.008)
(2 drought years)x(8th to 11th)	0.008
	(0.005)
(3+ drought years)x(8th to 11th)	0.015**
	(0.005)
(2 drought years)x(> 11th)	0.045***
	(0.010)
(3+ drought years)x(> 11th)	0.064***
	(0.009)
(2 drought years)x(Urban)	0.019
	(0.025)
(3+ drought years)x(Urban)	0.035**
	(0.015)
(2 drought years)x(8th to 11th)x(Urban)	0.001
	(0.007)
(3+ drought years)x(8th to 11th)x(Urban)	0.005
	(0.008)
(2 drought years)x(> 11th)x(Urban)	−0.016
	(0.014)
(3+ drought years)x(> 11th)x(Urban)	−0.002
	(0.010)
Observations	69,654,084

Standard errors clustered by 1935 state in parentheses

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

Notes: This table provides interaction results to evaluate the statistical significance of coefficient differences. The regression includes age and state fixed effects and individual and county controls as discussed in the context of Equation 1 and A1.

Table A5: Triple interaction for Figure 7: below and above average Depression severity

	(1) Migrant
2 drought years	−0.002
	(0.007)
3+ drought years	−0.006
	(0.007)
(2 drought years)x(8th to 11th)	0.004
	(0.006)
(3+ drought years)x(8th to 11th)	0.013***
	(0.004)
(2 drought years)x(> 11th)	0.026***
	(0.009)
(3+ drought years)x(> 11th)	0.056***
	(0.009)
(2 drought years)x(Severe Depression)	−0.001
	(0.002)
(3+ drought years)x(Severe Depression)	−0.006
	(0.004)
(2 drought years)x(8th to 11th)x(Severe Depression)	0.019
	(0.012)
(3+ drought years)x(8th to 11th)x(Severe Depression)	0.014**
	(0.006)
(2 drought years)x(> 11th)x(Severe Depression)	0.033*
	(0.016)
(3+ drought years)x(> 11th)x(Severe Depression)	0.032***
	(0.011)
Observations	69, 654, 084

Standard errors clustered by 1935 state in parentheses

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

Notes: This table provides interaction results in reference to Figure 7 to evaluate the statistical significance of coefficient differences. The regression includes age and state fixed effects and individual and county controls as discussed in the context of Equation 1 and A1.

Table A6: Robustness for Table 4: alternate drought measure

	(1) Migrant	(2) Migrant	(3) Migrant	(4) Migrant	(5) Migrant	(6) Migrant	(7) Migrant	(8) Migrant
Moderate	0.006	0.042***	-0.003	-0.014*		-0.024***	-0.017**	-0.017**
	(0.006)	(0.013)	(0.009)	(0.007)		(0.007)	(0.006)	(0.007)
Severe	0.024***	0.056***	-0.003	-0.013*		-0.021**	-0.010	-0.010
	(0.009)	(0.012)	(0.009)	(0.007)		(0.008)	(0.007)	(0.008)
(Moderate)x(8th to 11th)		0.028***	0.023***	0.018***	0.021**	0.017***	0.015**	0.015**
		(0.006)	(0.006)	(0.005)	(0.008)	(0.006)	(0.005)	(0.006)
(Severe)x(8th to 11th)		0.037***	0.027***	0.024***	0.027***	0.024***	0.023***	0.023***
		(0.005)	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)
(Moderate)x(> 11th)		0.066***	0.070***	0.062***	0.060***	0.057***	0.055***	0.055***
		(0.011)	(0.011)	(0.011)	(0.012)	(0.011)	(0.011)	(0.010)
(Severe)x(> 11th)		0.087***	0.086***	0.080***	0.079***	0.078***	0.078***	0.078***
		(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.014)	(0.011)
Observations	69,654,324	69,654,324	69,654,324	69,654,324	69,654,324	69,654,324	69,654,324	69,654,324
Controls	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	State and age	No	No	Region and age	County and age	SEA and age	State and age	State and age
Clustered standard errors	State	State	State	State	State	State	Conley	State

Standard errors clustered by 1935 state in parentheses

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

Notes: This table provides the results of rerunning the main results from Table 4 with an alternate drought measure as a robustness check. Regressions include age and state fixed effects and individual and county controls as discussed in the context of Equation 1.

Table A7: Robustness for Table 5: alternate drought measure

	(1) State migrant	(2) County migrant	(3) Rural (non-farm) migrant	(4) Farm migrant	(5) Urban migrant
Moderate	-0.008	-0.009**	-0.009*	-0.000	-0.008**
	(0.006)	(0.004)	(0.004)	(0.003)	(0.004)
Severe	-0.001	-0.009	-0.007	0.007	-0.009***
	(0.007)	(0.006)	(0.006)	(0.004)	(0.003)
(Moderate)x(8th to 11th)	0.013**	0.003	0.006***	0.006***	0.003
	(0.006)	(0.003)	(0.002)	(0.002)	(0.003)
(Severe)x(8th to 11th)	0.020***	0.004	0.013***	0.008***	0.003
	(0.005)	(0.003)	(0.002)	(0.003)	(0.002)
(Moderate)x(> 11th)	0.036***	0.019***	0.031***	-0.003	0.027***
	(0.011)	(0.007)	(0.005)	(0.002)	(0.007)
(Severe)x(> 11th)	0.048***	0.030***	0.053***	-0.005*	0.030***
	(0.010)	(0.005)	(0.006)	(0.003)	(0.006)
Observations	69,654,324	69,654,324	69,654,324	69,654,324	69,654,324

Standard errors in parentheses

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

Notes: This table provides the results of running the main sorting results from Table 5 with an alternate drought measure as a robustness check. Regressions include age and state fixed effects and individual and county controls as discussed in the context of Equation 1.