MIGRATION DURING THE GREAT AMERICAN DROUGHT

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This dissertation took on new relevance as I worked through the summer and fall of 2020 in Boulder, Colorado. This was an extremely dry period when the air was constantly filled with smoke from wildfires burning across the western United States. Studying drought in this context ingrained the concept that aridity and volatility define the wonderful, expansive, and unforgiving west.

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CHAPTER 1

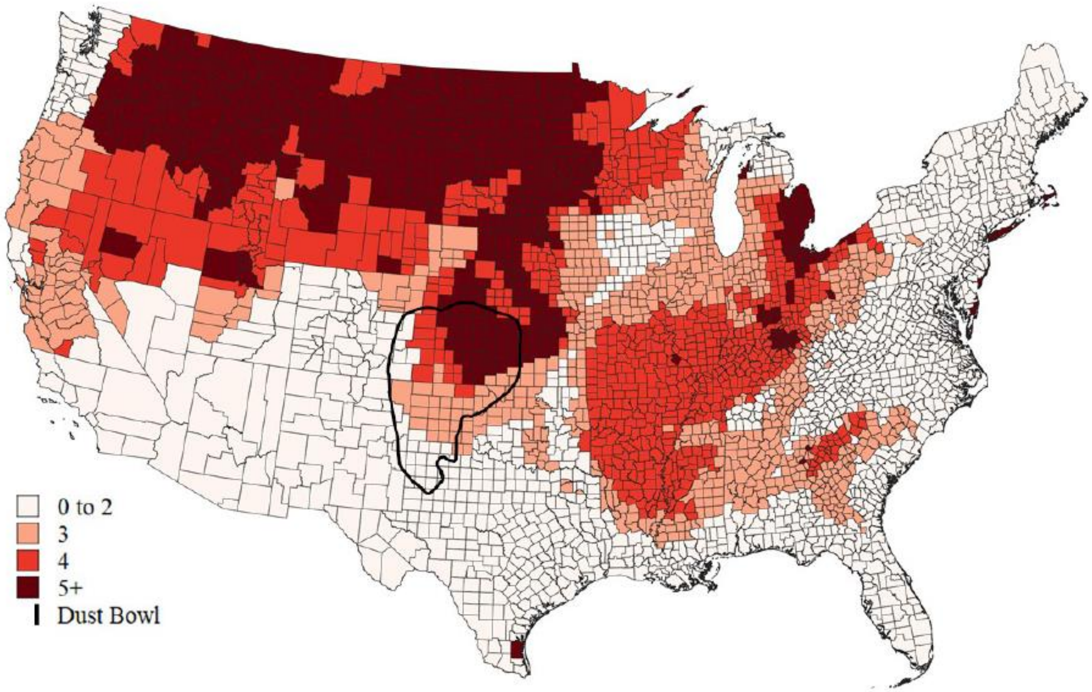
INTRODUCTION

Droughts, climatic events defined by lack of moisture and excess heat, are among the most destructive environmental shocks to impact the economy. Droughts influence people's standard of living, morbidity, and mortality by increasing crop failures and reducing agricultural output.[1] Moreover, abnormally high temperatures, which are often closely related to droughts, have large economic and health effects outside of their impact on the agricultural sector.[2] Due to these negative effects, people may want to move when faced with drought. But because migration is costly, complicated, and risky, not everyone who wishes to move has the resources to move, and not all moves are successful in mitigating the damages of negative environmental shocks.[3] Despite the economic importance of environmental shocks and their relationship with migration, we know little about who moves, where migrants go, and how migrants fare. This dissertation studies how a long and severe deviation in climatic conditions affected overall migration flows, the demographic composition of migrants, destinations, and the economic outcomes of migrants.

I study the worst decade of drought in U.S. history: the 1930s (Seager et al. 2008, Cook et al. 2010). A concentrated area of the drought—the Dust Bowl—has become central to both popular culture and scholarship.[4] The Dust Bowl was characterized by a combination of dust storms, wind

[1]See Adams et al. (1990), Mendelsohn and Sanghi (2001), Schlenker and Roberts (2006), Deschenes and Greenstone (2007), Libecap and Steckel (2011), Hornbeck and Keskin (2014), Bleakley and Hong (2017), and Feng et al. (2017).
[2] For recent literature see Barnett and Adger (2007) Jacob and Moretti (2007), Deshchenes and Moretti (2009), Hsiang (2010), Dell et al. (2012), and Barreca et al. (2016).
[3] For recent literature on the importance of financial constraints in migration decisions see Kleemans (2015) and Bazzi (2017).
[4] For the Dust Bowl in popular culture see Lange and Cox (1987), Guthrie (1988), Steinbeck (2006), Babb (2004) and Burns et al. (2012). For scholarship see Hurt (1981), Riney-Kehrberg (1989), Riney-Kehrberg (1994), Worster (2004),

Figure 1: Number of drought years 1930 to 1939



Notes: The drought of the 1930s was the worst ten-year period of drought in U.S. history. The drought started in 1930 and continued until 1939 through much of the Great Plains and northern mountain west. Years of moderate or worse drought are defined using the Living Blended Drought Atlas (Cook et al. 2010). The roughly 100 Dust Bowl counties outlined are the largest set of counties defined by the Soil Conservation Service as counties severely impacted by wind erosion during the 1930s (Natural Resources Conservation Service 2012). The *Dust Bowl* has never been a precise scholarly term as discussed in Chapter 2. This outline is simply intended to give an idea of the region of focus for previous literature. Data sources: Cook et al. (2010) and Manson et al. (2019).

erosion, and drought on the southern Great Plains. Dramatized accounts, such as John Steinbeck's *Grapes of Wrath* and Dorothea Lange's photographs, as well as published research, center on migration as a consequence of the Dust Bowl.[5] But as we expand geographically from the region that constituted the core of the Dust Bowl, we know less and less about how drought impacted migration. This is a problem because the Dust Bowl was a small fraction of the drought area and

Hansen and Libecap (2004), Cunfer (2005), Cutler et al. (2007), Hornbeck (2012), McLeman et al. (2014), Long and Siu (2018), Arthi (2018), and Hornbeck (2020).

[5] For research on migration see: Riney-Kehrberg (1989), Riney-Kehrberg (1994), Worster (2004), Cunfer (2005), Hornbeck (2012), McLeman et al. (2014), Long and Siu (2018), and Hornbeck (2020).

not representative of the whole (Figure 1). This dissertation is among the first to examine the economic consequences of the larger drought.

Understanding the migration response to drought, and environmental disasters in general, is important because migration is a key economic adjustment mechanism. Migration enables people to leave undesirable locations, which in turn has large implications for both the migrants themselves and for the broader economy (Greenwood 1975, Moretti 2011, Collins and Wanamaker 2014, Abramitzky and Boustan 2017). But at the same time, migration is a multifaceted decision that depends on social and economic conditions concerning whether to leave, where to go, and the financial ability to execute a move. Matters are further complicated in the context of climate shocks because these shocks heterogeneously impact people based on their occupation and economic circumstances. Therefore, to understand the consequences of migration from climate shocks, it is crucial to study the demographic composition of migrants, the characteristics of their destinations, and the economic outcomes of migrants and non-migrants.

To study the impact of drought on migration, I create new individual-level datasets that include detailed economic, demographic, and migration information for each person in conjunction with county-level drought conditions. For data on individuals, I use two U.S. population censuses (Minnesota Population Center 2017, Ruggles et al. 2019). First, I use a linked sample of men between the 1930 and 1940 full count censuses (Abramitzky et al. 2020). In this panel dataset, I observe information about each man (location, age, occupation, marital status, etc.) in both 1930 and 1940. That is, this dataset records the conditions of each man before and after the drought and migration (if applicable). Furthermore, as the 1940 census elicited a 1935 location for each individual, the linked census sample documents the county location of each man in 1930, 1935, and 1940. I use the linked census data to study migration flows at the county level in response to drought in Chapter 5 and to evaluate the labor market outcomes of migrants in Chapter 7.

Linked census data are excellent for studying people over time but there are a number of drawbacks (as discussed in Chapter 3). Specifically, because it is hard to uniquely identify individuals in both censuses, linked census data include only a subset of the original census (Bailey et al. 2020). This problem is especially apparent for women. Women are typically not linked because they often change their last name at marriage, making it impossible to uniquely identify the same woman in each census algorithmically with current techniques and computing.[6] Furthermore, the process of linking records is subject to false matches in which a record from the 1930 census is linked to a record of a different person in 1940. False matches are especially problematic in studies on migration because they often produce erroneous migration (Zimran 2021). Because of these drawbacks, and to enable the study of migration from drought for the entire adult population, I restrict my focus to the 1935 to 1940 period in Chapter 6, utilizing the records of 55 million adults aged 25 to 65 in 1935.

The census data provide extensive information on people but contain nothing on local climate conditions. To study the impact of drought, I link the census data with yearly drought conditions from the Living Blended Drought Atlas (LBDA) (Cook et al. 2010). The LBDA calculates local drought conditions across North America using instrument readings for the 20th century. I calculate yearly drought conditions for each county and for each year from 1930 to 1939 by integrating the LBDA with the 1930 county map (Manson et al. 2019). Finally, I match county-level covariates, including variables measuring the intensity of the Great Depression, the New Deal

[6] This is changing with the Census Tree Project, which is working to link all 188 million people that lived in the U.S. between 1900 and 1940 across each of their census records and will be especially useful for studying women in this time period (Price et al. 2019).

spending response, crop yield, and soil erosion (Fishback et al. 2005, Hornbeck 2012, Haines et al. 2018, Manson et al. 2019). In all, this new dataset enables the examination of migration related to drought in greater detail than any previous research.

The empirical results of this dissertation are divided into three chapters (5, 6, and 7). Each chapter explores unique but interconnected consequences of drought with a focus on migration. In Chapter 5, I estimate the impact of the number of drought years on county-level net migration, out-migration, and in-migration over the decade as a whole, and separately for the 1930 to 1935 and 1935 to 1940 periods. Here, and for the entire dissertation, migrants are defined as anyone observed living in a different county for the relevant time period.[7] I find that additional drought years impacted county-level migration measures over the 1930s as a whole. But the primary migration response to drought did not start until 1934, when the drought came to center and persist on the semi-arid Great Plains. Migration out of and away from drought continued through the second half of the decade. Counties that experienced three or more drought years from 1935 to 1939 witnessed a 3.9 percentage point decline in total population compared to similar counties with zero or one year of drought. The net population declines in drought counties were a function of both increased out-migration and decreased in-migration.

Chapter 5 shows that the migration response to drought was concentrated to the middle and late 1930s, which leads to the question: why did it take several years for drought to impact migration? Migration from drought was a function of time and intensity, as well as underlying climate, economic, and social conditions. Prior to 1934, the drought was not remarkably severe or prolonged, and because droughts are part of normal climate fluctuations, people expected and

[7] That is, an individual is defined as a migrant for the period from 1930 to 1935 if they were in a different county in 1935 compared to 1930. An individual is defined as a migrant for the period from 1935 to 1940 if they were in a different county in 1940 compared to 1935. Finally, an individual is defined as a migrant for the 1930 to 1940 period if they were in a different county in 1935 or 1940 compared to 1930.

planned for drought. The first year that differentiated the 1930s drought from previous droughts was 1934. The exceptional severity of drought in 1934 is recognized in climatology literature (Cook et al. 2007, 2014). Correspondingly, historical literature emphasizes a changing tide in the understanding of the seriousness of the environmental disaster by 1934.[8] It was the confluence of persistent and severe drought throughout the semi-arid Great Plains region that resulted in large population declines starting in 1934 and continuing through the late 1930s.[9]

Given that much of the migration response occurred in the second half of the decade and to utilize the full count 1940 census, Chapter 6 studies the composition and destinations of migrants from drought between 1935 to 1940 exclusively. In Chapter 6, I find that highly educated women and men from both city and rural areas increased their migration propensities in relation to drought. By contrast, drought was associated with a smaller increase in migration among individuals with an 8th to an 11th grade education and no additional migration for individuals with less than an 8th grade education. Therefore, drought in the late 1930s led to intermediate and positive selection into migration, meaning that more highly educated people moved away from the drought, whereas people with less education disproportionately stayed.

These findings on the differential impact of drought by individual human capital expand on previous research showing that migration from climate shocks is often concentrated to relatively high-income geographic segments of the impacted area (Cattaneo and Peri 2016, Bazzi 2017). Yet, previous findings do not differentiate whether the responsiveness in wealthier areas is driven by

[8] By 1934, especially after the dust storm in May in which dust fell as far east as the Atlantic Ocean, the drought on the Great Plain gathered national attention (Worster 2004).

[9] There is no other literature comparing the migration response to the broad drought between the early and late 1930s separately, but the finding that migration away from drought did not start until the mid-1930s is consistent with literature on Dust Bowl counties, which did not experience widespread out-migration until the late 1930s (Riney-Kehrberg 1989). Furthermore, historic accounts from popular destination states document an increasing flow of migrants starting in 1934 (Taylor and Vasey 1936, Hoffman 1938).

local amenities or responsiveness among affluent individuals in particular. I show that people with high human capital were *individually* more responsive to drought.

The typical explanation for why migration occurs among more affluent communities is that people with less wealth or human capital often lack the required cash on hand to pay for migration (Chiquar and Hanson 2005, Angelucci 2015, and Bazzi 2017). This explanation is consistent with the evidence during the 1930s. In a survey of people who persisted in Dust Bowl counties, the most common response to the question of "Why did you stay?" was that they lacked the resources to pay for migration. As one respondent stated, "We didn't have money to go anywhere so we just existed" (Riney-Kehrberg 1994). Additionally, I show that Depression severity (which made credit and cash harder to come by) further amplified positive selection into migration. Again, this finding is consistent with the hypothesis that lack of cash on hand constrained migration. The result that migration decisions of individuals with less human capital were inhibited suggests that access to liquidity and credit in the wake of environmental disasters is an important factor to enabling migration and thereby mitigating the heterogeneous impact of shocks.

I also study migrant destinations in Chapter 6 as migration is a decision of whether to move and where to go. I focus on whether migrants relocated to city or non-city locations as city status is a key characteristic of destinations in terms of employment type, employment opportunities, and way of life.[10] Additionally, because environmental shocks differentially impact sectors of the economy, previous studies on climate migrants focus on the rural-to-urban migration channel (Cohen 2016, Cattaneo and Peri 2016, Peri and Sasahara 2019). The rural-to-urban channel is a reasonable place to start, but climate shocks have widespread impacts outside of the rural and

[10] *City status* refers to whether an individual was designated as living in a city in the relevant census. Cities are defined as urban areas with more than 20 thousand residents in 1940. These locations are defined as *cities* by the Integrated Public Use Microdata Series (IPUMS) and are different from the IPUMS definition of *urban*, which include smaller urban areas of 2,500 residents or more.

agricultural sector (Hsiang 2010, Dell et al. 2012). Furthermore, apart from the potential impact of drought on the city sector, depending on the time and place, cities may not provide employment opportunities for displaced people for numerous reasons. Taken together, the rural-to-urban channel is important, but so are the rural-to-rural, urban-to-rural, and urban-to-urban migration channels. Therefore, Chapter 6 studies destination choice in the context of city status.

I find that most migrants relocated to non-city destinations. This was most pronounced among migrants who started in non-city locations but was also common for people who started in cities, with nearly 50 percent of such individuals relocating to non-city destinations. Additionally, in contrast to the focus on the rural-to-urban channel in previous climate migration research, I find that migrants who started in drought counties were *less* likely than other migrants to relocate to cities.[11] Considering these results, the focus on urbanization resulting from climate shocks obscures the experience and outcomes of typical migrants, at least during the 1930s.

Finally, popular narratives and published research on migrants from the Dust Bowl in particular stress the difficulties that migrants faced finding work at their destinations.[12] To study whether migrants from the broader drought also struggled economically, Chapter 7 examines how migrants and non-migrants were doing in 1940 in terms of labor market outcomes (employment and wages). I find that migrants from drought and non-drought counties were less likely to be employed at their destinations compared to similar non-migrants from their origin county. Furthermore, when migrants found work, it tended to pay the same as jobs held by non-migrants at their origin counties. There was, however, substantial heterogeneity in labor market outcomes based on education. Migrants with little education were less likely to be employed and had lower

[11] This result holds when controlling for extensive individual- and county-level controls including distance to the nearest city and state fixed effects.
[12] See Lange and Cox (1987), Worster (2004), Babb (2004), Steinbeck (2006), Burns et al. (2012), and Hornbeck (2020).

wages compared to similar non-migrants. Migrants with higher education fared better in finding employment and wage income.

In summary, the drought ebbed and flowed across the U.S. starting in 1930. But it was not until the drought settled on the semi-arid Great Plains and the surrounding area, in the middle and late 1930s, that large scale migration occurred out of and away from the drought region. Even then, in terms of migration responsiveness to local drought conditions, it was only the highly educated who increased their migration rates in response to drought severity. As a result, this drought was a story of unequal opportunity in which individuals with less human capital disproportionately persisted in drought counties and dealt with the negative consequences of drought. At the same time, migration was not an outlet that automatically led to economic prosperity. Migrants from both drought and non-drought counties often did not obtain gainful employment at their destinations. Labor market difficulties were especially acute for migrants with less than an 8th grade education, demonstrating the differential returns to migration based on individual human capital or skill.

These findings contribute to literature on the economic impacts of environmental shocks and migration. Much of previous environmental migration research focuses on the aggregate flows of migrants. This focus is in part because detailed data of individuals pre- and post-migration are not available for most times and places. This high-level perspective of migration introduces a number of questions regarding why people move from certain shocks but not others, and whether climate migrants differ from other migrants. The detail of the 1930 and 1940 censuses enables me to study the characteristics of migrants, where they went, and how they fared. In this way, this research contributes to a more nuanced understanding of impacts of environmental shocks and whether migration is an effective mitigation method.

I bring migration, settlement, and development of the U.S. into sharper focus by studying the overarching climate shock of the 1930s. This decade was pivotal, as the initial period of U.S. settlement on the Great Plains came to an end when the climate delivered a decisive correction to an economy that had overleveraged its natural resources. The depopulation of the Great Plains echoed through the coming century, and this region remains among the most sparsely populated parts of the United States. The drought changed the popular perception of the Plains from a land of opportunity to an arid and featureless region that should be avoided: the view that dominates sentiment to this day. This perception, however, is not representative of the inherent *value* of the Plains. As Egan (2006) states: it was the best place in the world for grass and for animals who ate grass. As we strive towards economies that utilize and amplify the natural world rather than trying to dominate it, the Great Plains are primed for sustainable economic progress as well as conservation and the reintroduction of native plants and animals.

I utilize nearly a century of previous research, data collection, data digitization, and advancements in computing and statistics to study the impact of drought in detail and scope not possible at earlier times. In doing so, this dissertation creates a more complete view of how an environmental catastrophe influenced the livelihood of millions, impacted migration, and altered the geographic population distribution of the United States. The drought caused incalculable hardship, but by studying how people responded, what methods worked and what went wrong, we enable ourselves to reduce the damage of current and future disasters.

CHAPTER 2

BACKGROUND: CLIMATE AND MIGRATION IN UNITED STATES HISTORY

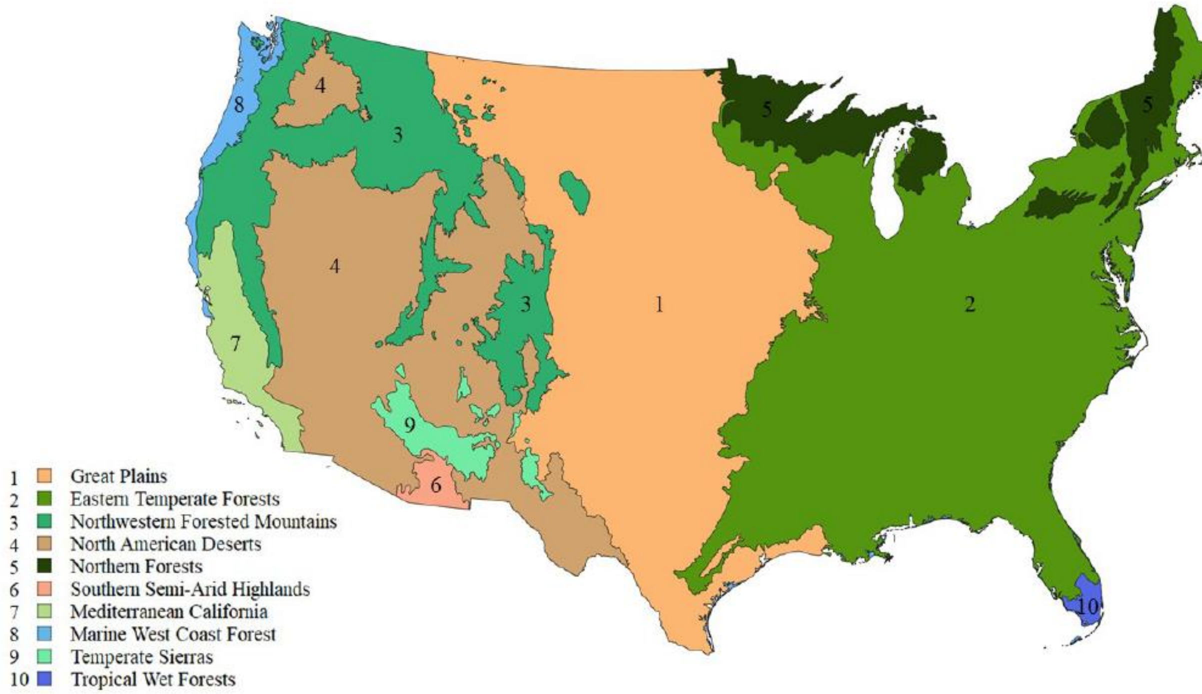
The 1930s were the worst ten-year period of drought in U.S. history, yet remain largely unstudied in terms of the economic impact of drought in general and its influence on migration in particular. This chapter explores U.S. settlement and economic development for the drought region with an emphasis on climate, migration, and the Great Depression. Drought and migration primarily intersected on the Great Plains, which is a semi-arid ecological region dependent on temporal fluctuations in water availability.

Climate and settlement of the United States through 1930

Climate conditions are key to understanding the geographic settlement and development of the U.S. including the migration response to drought. The aridity of the Great Plains led to an initial reluctance of European-Americans to settle the Plains. This reluctance gave way to opportunism and speculation in the early 20th century. The economic expansion faltered in the 1920s, given declining crop prices, and then collapsed in the 1930s as drought gripped the region.

The continental U.S. is composed of ecological regions defined by local climate conditions, displayed in Figure 2 (Omernik 2004). The predominant movement of weather systems in North America occurs from west to east. As low-pressure weather systems move inland from the Pacific Ocean, they traverse the Cascade or Sierra Nevada Mountains and then the Rocky Mountains. The mountain terrain adds orographic lift to air molecules, an event that subsequently cools the air. As

Figure 2: Ecological zones



Notes: This figure displays the ecological zones of the United States. The Great Plains (zone 1) are where drought came to center in the middle and late 1930s. This region is a semi-arid grassland that is prone to variation annual precipitation and temperature. Because of the aridity and variability of the Great Plains, the eastern and western U.S. was settled first by Anglo-Americans. It was not until the late 19th century and early 20th century the settlement frontier expanded onto the Great Plains. Data source: Omernik (2004).

the air cools, the water molecules contained in the air also cool, then they condense, and fall to the earth. This means that the Great Plains, which extend east from the foothills of the Rocky Mountains, sit in the rain shadow of the mountains. That is, the western mountains receive much of the precipitation that would otherwise be spread more equally over the United States. Yet drought is not necessarily based on lack of precipitation but rather a deviation from normal conditions. The Great Plains are dry but also have high variability in average precipitation, making this region particularly prone to drought (Kraenzel 1942).

The aridity and variability of the Great Plains was important to migration during the 1930s and stretching back through time.[13] The aridity of the Plains was not conducive to the agricultural and town-based economy of the U.S. and this region remained mostly unsettled by European-American U.S. residents as the population expanded westward. Instead, the Plains were largely bypassed for the west coast until the late-19th century (Webb 1959). The Plains were also a barrier to other European based expansion in North America including the Spanish in the south and the French and British in the north. Therefore, the Plains and its native inhabitants remained relatively outside of European and U.S. influence until the late-19th century.

The records of one of the first expeditions sanctioned by the U.S. government across the Plains in 1820 emphasize the perceived inhospitality of this region for European-American settlement. Upon his return, Stephen Long prepared a map in which he labeled the Great Plains as the "Great American Desert" (Webb 1959). Still, the late U.S. settlement should not be misinterpreted as reflective of an overall unsuitability of the Plains for human life. The Great Plains supported Native Americans stretching back at least 13 thousand years and staggering amounts of mega-fauna prior to settlement by non-indigenous migrants (Webb 1959, Flores 2016).

As with other land that incrementally came under the jurisdiction of the U.S., settlers interacted with, fought, and eventually killed and displaced native people that lived and often prospered on the Plains. Plains Native American tribes, including the Comanche, Arapahoe, Kiowa, and Cheyenne in the south and the Dakota, Teton, and Crow in the north, had developed societies and cultures based around horses and bison by the 19th century. U.S. expansion eventually undercut the power of the tribes through pressure from European-American settlement

[13] Land east of the Great Plains, the Eastern Temperate Forest in Figure 2, receives considerably more annual precipitation as moisture-infused weather systems from the Gulf of Mexico are more frequent in this region relative to the western United States.

and the extermination of buffalo (Webb 1959). After decades of warfare collectively known as the *Plains War*, the remaining Natives Americans were mostly confined to reservations and the Plains were opened to further U.S. settlement (Wooster 2009).

Initially, some ranching operations were established on the Plains but questions as to whether this region was suitable for widespread settlement and agriculture persisted (Webb 1959). Attitudes about the suitability of the Plains and the tide of settlement started to change in the middle of the 19th century, especially with the Homestead Act of the 1862 that allocated land to any settlers who could make it *productive* within the allotted time (Cunfer and Krausmann 2015). Wheats, specifically the red queen and hard red varieties, were well suited to the Plains and became the primary cash crop (Olmstead and Rhode 2002, Egan 2006). When drought came, the wheat crop struggled or failed. But despite some periods of drought and an understanding (still voiced by some) that the Plains would not support agriculture in the fashion of the eastern U.S., the population and agricultural development of the Plains expanded dramatically through the turn of the century.

In the early 20th century, U.S. settlement was buoyed by an unusually wet period, a growing belief that rainfall was endogenous to human activity, additional demand for agricultural produce during World War I, and agricultural mechanization (Alston 1983, Hansen and Libecap 2002). Between 1880 and 1925 over 1 million homesteads were started in western Kansas, Nebraska, the Dakotas, Colorado, and Montana (Hansen and Libecap 2002). Wheat prices quickly doubled with the outbreak of World War I (WWI) and the disruption of Russian wheat production in 1914 (Hurt 1981). This rapid increase in wheat prices led to more marginal land being put into agricultural production, increased mortgage debt, and escalated land values (Alston 1983). Furthermore, this agricultural expansion coincided with the adoption of powered machinery, including tractors, which greatly reduced the manual labor required to plant and harvest wheat (Hurt 1981, Worster 2002). In short, the Great Plains experienced a swift and expansive integration into the U.S. market economy in the late 19th and early 20th century.

This economic expansion began to falter in the 1920s with the reintroduction of wheat from Russia following the end of WWI. Collapsing wheat prices made farm debt obligations difficult or impossible for many farmers to meet. This caused a vicious circle in which land values fell, farmer equity decreased, and farm foreclosures increased. This pattern occurred across much of the U.S. and was especially pronounced for many Great Plains states (Alston 1983).

As bad as the 1920s were for farmers and the Plains, crop yields remained high and the broader U.S. economy grew rapidly. This changed starting 1929 when investment, consumption, production, and the stock market began a steep downward trend culminating in 1933 (Eichengreen 1992, Romer 1993, Bernanke 2000). Simultaneously, in 1930 and 1931, the U.S. experienced the first wave of drought that would persist in some areas through 1939. The drought bore down on the Plains starting in 1932 and had devastating consequences until it subsided in late 1939. The geographic and temporal details of the drought are further detailed in Chapter 3 using a new dataset of county-level drought conditions.

The Dust Bowl and associated migration during the 1930s

Considering the magnitude of the 1930s drought, we know little about its overall economic impact. Yet, one portion of the drought, colloquially known as the Dust Bowl, has been studied extensively.[14] The Dust Bowl was categorized by drought, wind erosion, and dust storms, and was important for the economic development and migration in the southern Great Plains. Still, as

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[14] For economic history see Hansen and Libecap (2004), Hornbeck (2012, 2020), Long and Siu (2018) and Arthi (2018). For history see Bonnifield (1979), Hurt (1981), Riney-Kehrberg (1994), Worster (2002), and Cunfer (2008).

Figure 1 displays, the Dust Bowl was a fraction of a much more widespread drought. This section details what we know about the Dust Bowl, the associated migration, and how the Dust Bowl fits inside the context of the broader drought.

Relative to earlier and later droughts, the 1930s drought met the topsoil exposed by the agricultural boom of the early 20th century (Libecap and Hansen 2004). Additionally, whereas the native grasses of the Plains have deep root system that help to hold the soil together, domesticated crops typically have much shallower root systems (Worster 2002). Given the exposed topsoil and shallowly rooted crops, the strong and persistent winds of the Plains swept up billions of tons of soil, dried and decimated by drought, and culminated in massive dust storms. Historically, dust storms were not uncommon and still occur today but the storms of the 1930s were more severe and common than ever before or since (Hansen and Libecap 2004).

The dust storm began to gather national interest as they became increasingly common and severe. After a particularly severe dust storm on April 14, 1935 "Black Sunday" the reporter Robert Geiger coined the term *Dust Bowl* in reference to the worst impacted area. The phrase Dust Bowl stuck and the southern Great Plains had a new identity that still resonates today (Worster 2002). The Soil Conservation Service (SCS) in the United States Department of Agriculture adopted Geiger's Dust Bowl terminology to define 20 counties at the intersection of Colorado, Oklahoma, Kansas, Texas, and New Mexico as the area most adversely affected by dust storms and wind erosion (Joel 1937, Cunfer 2007). These 20 counties became the epicenter of interest in environmental degradation in the 1930s. As we expand from these counties, we know less and less about how environmental shocks, including drought, impacted the economy.[15]

[15] The SCS later designated roughly 100 more counties in the southern Great Plains as having suffered severe wind erosion (Natural Resources Conservation Service 2012). This area is outlined and labeled as the Dust Bowl in Figure 1. While the Dust Bowl terminology was adopted by the SCS in reference to specific counties, the Dust Bowl has never been a precise scholarly term. Instead, the term Dust Bowl has been, and continues to be, used in a variety of

The southern Great Plains became the focus of not only government interest and research but of popularized accounts. Books such as *Grapes of Wrath* by John Steinbeck and *Whose Names Are Unknown* by Sanora Babb, photographs, especially those by Dorothea Lange, albums such as *Dust Bowl Ballads* by Woody Guthrie, and documentaries such as *The Dust Bowl* by Ken Burns have had a lasting impact on the U.S. historical narrative. All of these accounts focus on the impact of drought, dust storms, economic devastation in the Dust Bowl to the exclusion of the wider drought.

In both popularized accounts and published research, migration has likely been the most studied economic repercussion related to environmental degradation (Hurt 1981, Riney-Kehrberg 1994, Worster 2004, Hornbeck 2012, Long and Siu 2018, Hornbeck 2020). For the Dust Bowl counties, migration rates were high during the 1930s but were also high during the 1920s (Long and Siu 2018). The net decline in population for the 20 counties at the core of the Dust Bowl was largely due to a decrease in in-migration rather than an increase in out-migration. More broadly, counties suffering soil erosion throughout the Great Plains saw large population declines through to the 1950s (Hornbeck 2012). Finally, outside the bounds of the Dust Bowl, even by its broadest definition, people left hot and dry areas through much of the western U.S. in the late 1930s (Gutmann et al. 2016).

While understanding whether a region is gaining or losing population is the first step to any study of migration, migrants are rarely representative in terms of their social and economic characteristics compared to non-migrants. Therefore, questions concerning who is moving or

ways. Most often *Dust Bowl* is used to describe the southern Great Plains (Hurt 1981, Worster 2001, Riney-Kehrberg 1994, Cunfer 2011, Long and Siu 2018) and sometimes the term is used to designate the entire Great Plains (Hornbeck 2012, Arthi 2018, Hornbeck 2020). Regardless of imprecise usage of the term Dust Bowl, social science research related to the 1930s drought has focused on the southern Great Plains and to a lesser extent on soil erosion through the Great Plains. Only Gutmann et al. (2016) consider the impact of variation in heat and precipitation for the U.S. as a whole. Porter and Finchum (2009) likely provide the most complete accounting for what constituted the Dust Bowl in terms of historical vernacular.

selection into migration are central to understanding the economic consequence of migration. Migrant characteristics influence both the likelihood of personal success or failure for migrants and impact the distribution of labor and skills in the economy (Collins and Wanamaker 2014, Abramitzky et al. 2012). Certain characteristics, such as being young and having the money on hand to pay for the cost of migration, are key to determining whether someone moves and may be particularly important during times of economic distress.

In terms of the demographic composition of migrants leaving the Plains, average migrants had more years of education compared to average non-migrants. Yet, this pattern was less pronounced in counties with more severe soil erosion (Hornbeck 2020).[16] This dissertation expands on previous research by studying how the widespread drought impacted migration flows overall, but also how the drought impacted migration choices for individuals based on human capital (education) and how individual migrants fared at their destinations. That is, this dissertation expands on previous research in terms of the geographic scope, the characteristics of the environmental shock, and details of the heterogeneous migration response and labor market repercussions.

It is not clear why the southern Great Plains became the epicenter of interest related to environmental disaster while the larger drought has been neglected. Most likely, the dust storms reached their greatest frequency and force on the southern Great Plains. The geographic distribution of the storms, combined with the fact that these storms were an early and extreme

[16] The results of Hornbeck (2020) at first glance might appear contradictory to my results in Chapter 6. But there are a few factors to consider when comparing my results to Hornbeck (2020). First, soil erosion and drought were related but distinct environmental shocks. From a technical perspective, the worst drought was both north and west of the worst soil erosion on the Great Plains. Moreover, while the drought ebbed and flowed for a decade, when the rains returned in 1940 the lasting impact of the drought likely receded quickly apart from the erosion damage, which became a long-term problem. Finally, Hornbeck (2020) studies whether the *average* migrant was positively or negatively selected, whereas I am studying whether drought increased the propensity of individuals to migrate differentially by human capital. These topics are discussed more in Chapter 3 and the Appendix.

example of devastation caused by natural resource exploitation, likely captured the imaginations of novelists, photographers, musicians, researchers, and the nation as a whole to a greater extent than heat, lack of rain, and decimated soil alone.

For whatever reason, the larger drought has been understudied given its severity and magnitude. Moreover, only recently has research started to use variation in local intensity to isolate the impact of environmental shocks relative to other phenomena in the 1930s (Hornbeck 2012, Arthi 2018, Hornbeck 2020). Much of the existing research documenting social and economic conditions related to environmental degradation is qualitative (rich in details and personal accounts) but not aimed at measuring how environmental conditions impacted economic outcomes compared to other local circumstances. I examine the widespread drought and estimate how local conditions impacted individual- and county-level migration.

The Great Depression

The Great Depression was the worst economic downturn in U.S. history and defined American life during the 1930s. To study migration and drought, it is necessary to understand how the Great Depression influenced migration and how the Depression was related to drought. This section contains a brief history of the Great Depression with an emphasis on migration. As stated in the previous section, there is little research on the impact of drought (outside of the Dust Bowl) on economic activity during the 1930s. Therefore, details on the relationship between drought and the Great Depression are mostly in Chapters 3 and 5.

Investment, consumption, production, employment, and the stock market fell precipitously starting in 1929 and reaching a trough in 1933 (Eichengreen 1992, Romer 1993, Bernanke 2000). The Great Depression started before the drought, so drought cannot be added to the list of potential sparks of the Great Depression. But the Depression stretched the entire decade and given the long temporal overlap with the drought, there is little research on the relationship between the Depression and drought. For this reason, and to better understand how droughts impact economic activity, I examine how drought was related to Depression severity at the county-level and potential channels through which the drought impacted the economy in Chapter 5.

In contrast to a paucity of research on the impact of drought on the Depression, there is much research on the relationship between the Depression and migration. In terms of how the Depression impacted migration from a broad perspective, economic downturns typically temporarily decrease migration. This was the case for the 1930s as there was little internal migration compared to earlier and later decades (Molloy et al. 2011, Saks and Wozniak 2011).

Even with low overall mobility, changes in internal migration patterns (including large numbers of economically distressed migrants arriving on the west coast) prompted the Census Bureau to record place of residence within a decade for the first time in 1940. The recording of individuals' 1935 location combined with the innovation of linking between censuses enables the study of migration from 1930 to 1935 and from 1935 to 1940, as I do in Chapter 5. This is an expansion on previous research, which focuses on more aggregate measures of migration over the entire decade or individual migration during the 1935 to 1940 period.

Federal relief spending (allocated in response to the Great Depression) also impacted migration. The federal government began to distribute New Deal grants in 1933 after Franklin D. Roosevelt took office. In total, the federal government distributed $16.5 billion ($326 billion in 2021 value) in grants from 1933 to 1939 (Fishback et al. 2005, Fishback 2017).[17] The two main components of New Deal spending were public works and relief grants, and the Agricultural

[17] The price adjustment was made using the Bureau of Labor Statistics' Consumer Price Index Inflation Calculator: https://www.bls.gov/data/inflation_calculator.htm.

Adjustment Act (AAA). AAA spending aided the drought stricken agricultural communities of the Great Plains with the highest proportion of money targeted at the Dust Bowl. Public works and relief spending was associated with changing migration trends, and because AAA spending targeted farm-owners and large-scale farmers, AAA payments in particular were associated with greater out-migration among tenants, sharecroppers, and farm workers (Fishback et al. 2006).

Large and concentrated movements of people, such as those witnessed in the 1930s, spur debates about the costs and benefits of migration in terms of how migrants integrate into the society and economy at their destinations (Abramitzky 2014, Collins and Zimran 2019b). This was certainly true in the context of the stressed labor markets of the 1930s, when prejudice towards internal migrants displacing local workers and driving down wages was well documented (Taylor and Vasey 1936, Hoffman 1938). These prejudices were strong in California and directed towards people who locals perceived as Dust Bowl migrants (Hurt 1984, Worster 2004). Fears of migrants negatively impacting local employment were not unfounded, as for every 10 arrivals to U.S. cities, 1.9 residents moved out, 2.1 were prevented from finding a relief job, and 1.9 shifted from fulltime to parttime work (Boustan et al. 2010).

In terms of how migrants themselves fared, certainly the perceptions popularized by John Steinbeck, Dorothea Lange, Senora Babb, and Ken Burns were of migrants who struggled to find work at their destinations. These narratives are consistent with the economic outcomes estimated for the typical migrant from the Great Plains (Hornbeck 2020).[18] Still, compared to the pervasiveness of stories and images of destitute migrants, little research systematically studies how

[18] For individuals moving from Depression severity throughout the U.S. (not necessarily related to environmental degradation) there was substantial variation in the outcomes of migrants based on their human capital and socio-economic conditions before migrating (at least in the case of young men). Young men's migration success depended on destination choice and the sons of wealthier families migrated to cities with less severe economic downturns and thereby alleviating some future economic hardship (Feigenbaum 2015).

migrants fared during the 1930s in general, and from drought in particular. Furthermore, no previous research studies heterogeneity in labor market outcomes for environmental migrants based on education, as I do in Chapter 7, despite previous research stressing the importance of human capital in the returns to migration (Sjaastad 1962, Borjas 1987).

Overall, the drought, depopulation, and Depression overlapped on the Great Plains of North America. The Great Plains had been settled by European-Americans relatively recently and subsequently witnessed a large decline in population. Despite of the magnitude of this migration, the extent of drought, and the precedence this episode set for future migration, settlement, and development, we know little about how drought impacted the economy and migration apart of the geographically small area of the Dust Bowl.

CHAPTER 3

DATA

To understand how drought influenced migration, I create new datasets of individuals and drought conditions by combining U.S. population census data and drought data. This chapter explains the creation of these datasets and provides descriptive statistics for variables of interest. I use two primary types of data. First are individual-level data from the 1930 and 1940 U.S. censuses (Minnesota Population Center 2017, Ruggles et al. 2019). Second are county-level data on drought conditions from 1930 to 1939 (Cook et al. 2010, Manson et al. 2019). These datasets allow me to match adults, aged 20 to 60 in 1930, to drought conditions at the county-level based on their 1930, 1935, and 1940 locations.

To study individual-level migration and to obtain demographic information of individuals, I use a linked dataset of men between the 1930 and 1940 censuses, which is publicly available from the Census Linking Project (Abramitzky et al. 2020).[19] Algorithmically linking individuals between censuses is a process by which the same person is identified in both the 1930 and 1940 census using their name, birthplace, and age as described in more detail below. This linked census dataset is used in Chapters 4, 5, and 7 and is the basis for all migration maps in those chapters. In addition to the linked census data, I also use the full count 1940 census in Chapter 6 (Ruggles et al. 2019). The 1940 census includes 1935 county locations for all individuals, which enables me

[19] The Census Linking Project provides the historical identification numbers for men that they were able to find in both the 1930 and 1940 census. This data set must then be matched with the 1930 and 1940 censuses available from IPUMS (Ruggles et al. 2019) for demographic information of each man in each census.

to study migration from drought from 1935 to 1940 for the entire adult population of the United States.

The population censuses recorded detailed information on social and economic characteristics of individuals but contain no information on local weather or climate conditions. I therefore link census data with county-level measures of drought severity for each year. The Living Blended Drought Atlas (LBDA) provides yearly drought conditions and is available publicly from the National Atmospheric and Oceanic Administration (NOAA) (Cook et al. 2010). To utilize this drought data with county-level location of individuals, I match the drought data with the 1930 county map in a process described in detail below (Manson et al. 2019).

Finally, to control for covariates that might affect the decisions to migrate, I merge the census and drought data with county-level variables on Depression severity, New Deal spending, agricultural output, and soil erosion. Data on Depression severity and New Deal spending come from Fishback et al. (2005). Agricultural census data are taken from Haines et al. (2018) and were geocoded by Manson et al. (2019). Other county-level control variables, including soil erosion, are from Hornbeck (2012). In total, this new dataset of individual census data and county-level drought conditions, combined with numerous county-level covariates, provides the basis for studying the impact of drought on migration and represents the most complete accounting of the forces determining migration during this period.

Census data

The 1930 and 1940 U.S. population censuses enable detailed social and economic research at the individual level. These census data include all individuals (*full count* data) with county-level locations. U.S. census data with individual identifiers including county location do not enter the public domain for 72 years in an effort to protect personal information.[20] The public release of the 1930 and 1940 censuses, and the digitization of these records by the Integrated Public Use Microdata Series (IPUMS) and Ancestry.com, allows researchers to link observations between censuses, and thereby produce panel datasets of individuals. Moreover, historic U.S. censuses, and the 1930 and 1940 censuses in particular, contain extensive demographic and socio-economic information compared to more modern censuses.[21]

The 1940 census forms the basis for analysis. Because this was the first census to record place of residence five years prior, it captures internal migration from 1935 to 1940 for the entire population. The overlap between the worst drought in U.S. history and the 1940 census creates an exceptional opportunity to study how a monumental environmental shock impacted migration for a large and economically diverse country. The ability to study migration decisions at the individual-level for so many people in the wake of such a large climate shock is not possible at any other place or time in human history to my knowledge. Furthermore, the 1940 census recorded the highest grade achieved for each person, which provides a measure of individual human capital for the adult population. I utilize this comprehensive dataset in Chapter 6 by studying the heterogeneous response to drought conditions by individual human capital from 1935 to 1940.

Linked census data

In Chapters 5 and 7, I use data linked between the 1930 and 1940 censuses, which enable me to study migration over the entire decade, and provide detailed demographics of the same men

[20] The *72-Year Rule* means that the 1940 census, at the time of writing this dissertation, is the most recent census to be publicly released in full detail.

[21] More recent censuses are less thorough as the Census Bureau has transitioned to obtaining detailed demographics for only a fraction of the population using the American Community Survey (Macdonald 2006).

in both 1930 and 1940.[22] The process of algorithmically linking historic U.S. censuses together has been a major innovation in the field of economics over the last three decades. Census linkage has catalyzed the study of numerous microeconomic questions, including labor market transitions, social and economic mobility, and migration (Abramitzky et al. 2012, Collins and Wanamaker 2014). This section outlines the procedure for linking between censuses, potential issues when using linked census data, and the steps I take to mitigate these issues.

The goal of linking censuses is to match an observation of an individual in one census to the corresponding observation of that individual in another census for as many people as possible, using information that did not change between censuses. Census linkage is complicated by the fact that many people in each census cannot be uniquely identified. This situation leads to the two primary concerns when using linked census data. The first problem with modern census linking algorithms is that they link only a fraction of individuals between censuses. This means that the linked sample may not be a representative sample of the original population. That is, there is *selection into linking*. A stark example of selection into linkage is that women are much harder to match between censuses because they frequently changed their last name at marriage. Therefore, most research using linked census data studies only men. The second problem with census-linking algorithms is that they are subject to false positives: linking a 1930 census record to the wrong 1940 census record (Bailey et al. 2020). False positives are especially problematic for studies on migration because false positives often create spurious inter-county migrations (Zimran 2021). A number of linking and statistical techniques mitigate potential bias from both selection into linkage and false positives.

[22] In Chapter 5 the individual-level data is aggregated to the county-level measures to provide a higher-level perspective of how drought impacted migration patterns.

The linked census data used in this dissertation are from the Census Linking Project and are designed to minimize both selection into linkage and false positives while linking as many men as possible between censuses. The Census Linking Project links men between censuses based on their recorded name, birth year, and place of birth with four different linking algorithms (Abramitzky et al. 2020). In total, the Census linking Project links 22.4 million men between the 1930 and 1940 censuses out of 62.1 million men in the 1930 census.

Because this dissertation focuses on migration and because false linkages create spurious migrations, I mitigate the risk of false linkages in this dataset with two steps beyond the careful work of Abramitzky et al. (2020). First, I use only linkages that are linked by both of the two most conservative linking algorithms. These linking algorithms require individuals to have a unique name and birthplace combination within a five-year age band for each census and are effective in reducing false matches (Abramitzky et al. 2019). This step brings the linked sample down to 9.1 million men. Second, out of these matches, I keep only linkages of men who reported the exact same age (plus 10 years) in the 1940 census compared to the 1930 census. This brings the linked sample to 6.3 million men. In all, this is an extremely conservative linking criteria that minimizes the number of false links. Although it is not possible to know the exact portion of false matches, given the strict linking criteria adopted in this dissertation and the computed false linkage rates among different linkage algorithms in Abramitzky et al. (2019), it is likely that the false linkage rate for this dataset does not exceed ten percent.

The second concern in using linked census data is that the linked sample is not representative of the entire population. For example, men with better education may be more likely to report consistent information to census enumerators, and name uniqueness varies by country of origin and other characteristics (Collins and Zimran 2019a). To start to look at and account for

Table 1: Demographics of men in linked and full samples

	(1) 1930 linked sample unweighted	(2) 1930 linked sample weighted	(3) 1930 full count	(4) 1940 linked sample unweighted	(5) 1940 linked sample weighted	(6) 1940 full count
Average age	36.2	36.5	37.2	46.2	46.5	46.5
Fraction employed	90.1	88.7	88.4	86.6	82.4	82.7
Average occupation score	20.0	19.5	19.8	24.1	22.8	22.8
Fraction home owner	51.2	46.9	47.3	53.9	45.6	45.3
Fraction house hold head	73.2	70.3	71.3	86.7	80.2	80.5
Fraction married	74.7	71.7	73.7	85.8	79.5	79.7
Fraction white	97.3	90.8	91.7	97.4	90.4	90.6
Fraction in city	46.8	50.4	50.6	43.8	49.6	49.5
Fraction on farm	24.9	22.7	21.9	24.0	20.4	20.7
Average highest grade				8.7	8.1	7.8
Average wage income				$999	$929	$890
Observations	2,811,829	2,811,829	33,368,029	2,811,829	2,811,829	28,776,391

Notes: This table shows the demographics of the linked census sample from 1930 to 1940 and the demographics for the full count 1930 and 1940 censuses of men aged 20 to 60 in 1930. The linked sample is fairly representative of the full count census. But because some variables (*fraction white* for example) vary considerably between the linked sample and the full count, I weight the linked sample with the inverse probability of the likelihood of being linked. The weighted linked sample is very similar to the full count census demographics in both 1930 and 1940. Data sources: Ruggles et al. (2019) and Abramitzky et al. (2020).

selection into linkage, Table 1 compares the demographics of the linked sample to the full count censuses of men in the relevant age range.[23]

The linked sample consists of 2.8 million men aged 20 to 60 in 1930 (column 1) compared to the 33.4 million men between the ages 20 and 60 in the 1930 census as a whole (column 3). Overall, the linked sample is similar to the full count censuses in terms of demographics. But because a number of variables differ substantially (*fraction white* for example), I reweight the linked sample with inverse probability weights based on a probit regression for successful linkage. This regression and the weighting are discussed in detail in the Appendix. The demographics of the weighted linked sample are listed in column 2 and align closely with the demographics of the full sample of adult men. Moreover, columns 4 through 6 make the same comparisons between the linked sample and the 1940 full count census. All analyses in this paper that use the linked census sample, use the weighted linked sample. Finally, to mitigate concerns of the results being

[23] Because this dissertation is focused on the movement of labor in the 1930s, I study only men aged 20 to 60 in 1930.

biased by linking criteria, I validate the main results of this paper in the Appendix with alternate linking criteria.

In summary, algorithmically linking censuses creates a dataset of the same individuals and their demographic characteristics in 1930 and 1940, and individual locations in 1930, 1935, and 1940. This dataset enables the study of migration for the periods of 1930 to 1940 and from 1930 to 1935 and is the data used in Chapter 5. Moreover, this dataset allows me to study how conditions changed for individuals from 1930 to 1940 in Chapter 7 and to control for individual characteristics in 1930 when estimating labor market outcomes.

Drought data

To study the impact of drought, I match census records with a dataset of drought conditions. I create a dataset of county-level drought by linking local historic drought conditions with the 1930 map of U.S. counties (Cook et al. 2010, Manson et al. 2019). This new dataset enables me to analyze the impact of drought in geographic and temporal detail.

Data measuring yearly drought intensity are from the U.S. National Atmospheric and Oceanic Administration (NOAA): The Living Blended Drought Atlas (LBDA) (Cook et al. 2010). The LBDA is a recent iteration of the Palmer Drought Severity Index (PDSI). The PDSI has become the standard method for measuring variation in drought severity across time and space since its creation in 1969 (Palmer 1969).[24] Meteorological drought is an anomaly of prolonged and abnormally low soil moisture relative to the local average (Palmer 1965). That is, the PDSI estimates drought relative to local average conditions. Therefore, a moderate drought in Boulder,

[24] Alley (1984) offers a complete detailing of the calculations that create the PDSI. Alley (1984) also critiques aspects of the PDSI as it was used in the 1980s. Most of these criticisms are fixed in later computations of the index including the LBDA.

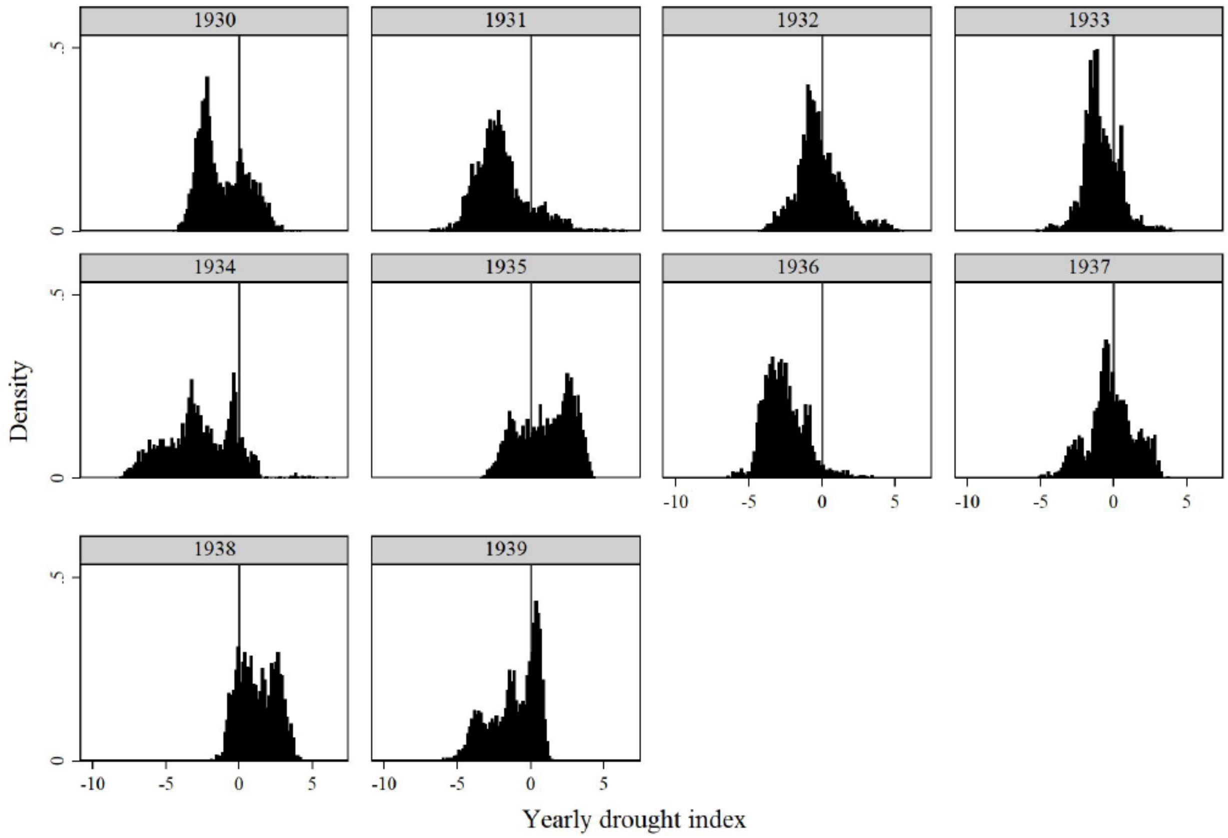
Colorado, with low average annual rainfall, is characterized by dryer soil relative to a moderate drought in Nashville, Tennessee, with high average annual rainfall. The data used for this paper, the LBDA, estimate yearly drought conditions in the 20th century based on instrument records of heat, rain, wind, soil, runoff, and evaporation for a grid of 11 thousand points across North America and computes drought severity relative to conditions measured during the calibration period of 1928 to 1978 (Cook et al. 2010).[25]

The LBDA data measure localized drought conditions across North America but contains no geographic variables that enable direct linkage to census data. To utilize the LBDA in connection with census data, I calculate the average drought by year and county by geospatially matching the LBDA to U.S. county maps (Manson et al. 2019) in the software program ArcGIS. First, the grid of drought conditions is interpolated using inverse distance weighting. Then, I calculate the average drought recorded within the boundary lines of each county for each year. I algorithmically repeat this process (of linking local yearly drought conditions to the relevant county map) for every year from 1850 to 1949 to show that the 1930s were an outstanding decade of drought and in anticipation of further research on the economic impact of drought. This new dataset on historic county-level drought conditions has many research applications and is available upon request.

To gain an understanding of the distribution of the yearly LBDA data at the county level in the 1930s and to show how the drought progressed through the decade, Figure 3 displays yearly histograms of drought index values for the 3,073 counties in my sample from 1930 to 1939. Counties with an index value of zero (indicated by the black line in each subfigure) are at the long-

[25] The LBDA also estimates drought conditions pre-instrument recordings by functionally fitting the instrument readings to tree-ring records, then projects past drought conditions based on this function and historic tree ring observations.

Figure 3: Histograms of county LBDA (PDSI) values for each year 1930 to 1939



Notes: The vertical line in each histogram indicates a drought index value of zero. Counties with an index value of zero are at the long-run average soil moisture for that year. Index values below zero indicate counties with lower-than-average soil moisture, while values above zero indicate counties with higher-than-average soil moisture. The drought largely came in four waves: 1930 and 1931, 1934, 1936, and 1939. The mass of these histograms is left of zero indicating that most counties suffered drought conditions, whereas in non-drought years the histograms are roughly mean zero indicating that some counties had moisture deficiencies and some had excess moisture but overall conditions were normal. Data sources: Cook et al. (2010) and Manson et al. (2019).

run average soil moisture in that year. Index values below zero indicate counties with lower-than-average soil moisture (drought), while values above zero indicate counties with higher-than-average soil moisture. The geographic extent and severity of drought peaked in four waves: 1930 and 1931, 1934, 1936, and 1939. The average of the drought histograms for these years is to the left of zero, which shows that many counties experienced drought. The fact that the drought occurred in four waves does not mean that there were not drought conditions in other years, nor does it mean that there were not counties that suffered drought almost every year.

Table 2: Classification of wet and dry conditions for yearly LBDA (PDSI)

Qualitative description	Index value
Extreme drought	-4.00 or less
Severe drought	-3.00 to -3.99
Moderate drought	-2.00 to -2.99
Mild drought	-1.00 to -1.99
Incipient dry spell	-0.50 to -0.99
Near normal	0.49 to -0.49
Incipient wet spell	0.50 to 0.99
Slightly wet	1.00 to 1.99
Moderately wet	2.00 to 2.99
Very wet	3.00 to 3.99
Extremely wet	4.00 or more

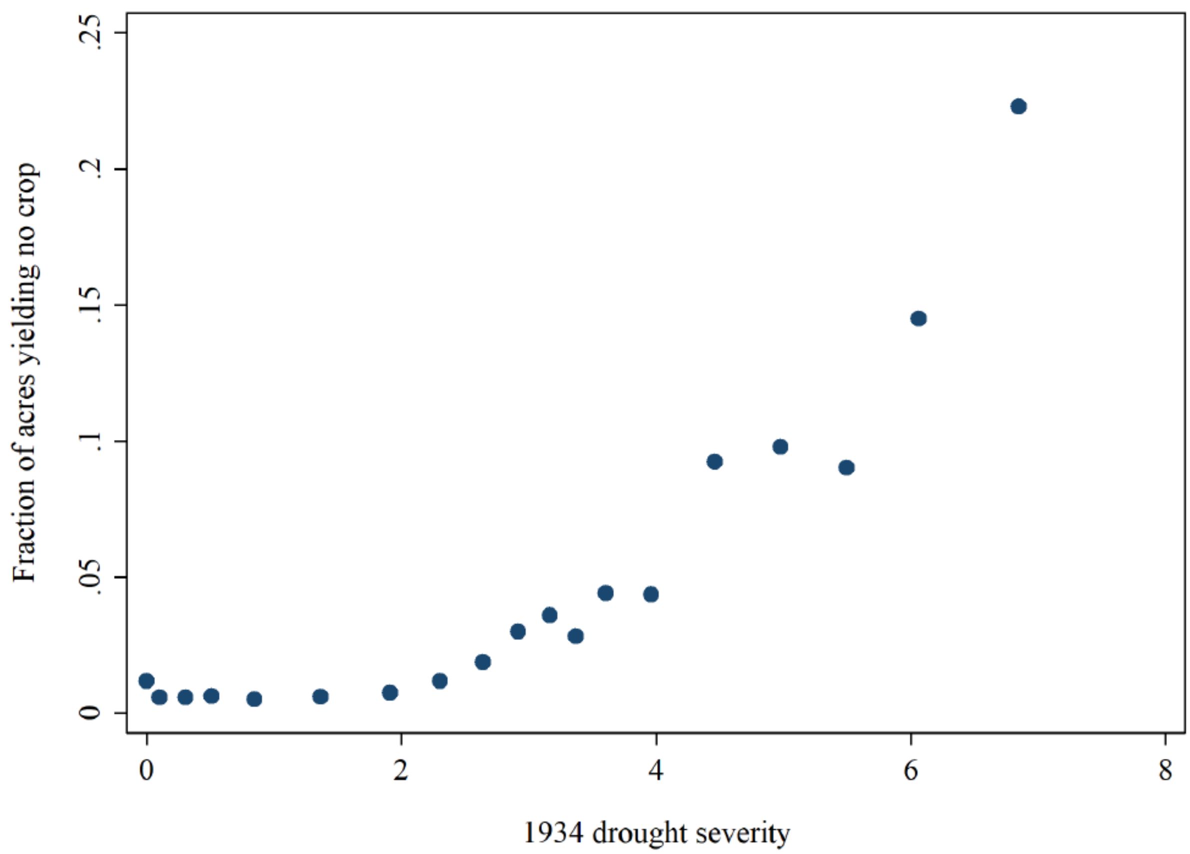
Note: This table displays the qualitative definitions of index values in terms of drought severity. The Living Blended Drought Atlas (LBDA), as a recent iteration of the Palmer Drought Severity Index (PDSI), defines drought severity at the yearly level as an index value. Source: Cook et al. (2007).

To describe what drought index values mean in terms of economic impacts, Table 2 displays the numeric drought index values and the corresponding qualitative description of drought severity (Cook et al. 2007). Each category is designed and designated in terms of how such a deviation in climate conditions is expected to impact agriculture and the economy. For example, a moderate drought, index value of -2.00 to -2.99, is expected to do some damage to crops and pastures and to decrease the volume of streams, reservoirs, and wells to the point of developing some water shortages (U.S. Drought Monitor).[26] These defined thresholds hold true for the 1930s. For example, Figure 4 is a binned scatter plot of county-level drought and crop failure in 1934.[27]

[26] 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.

[27] I use 1934 because the agricultural census was taken every five years. Furthermore, 1934 was the worst single year of drought in U.S. history.

Figure 4: Binned scatter plot of 1934 county crop failure and drought index

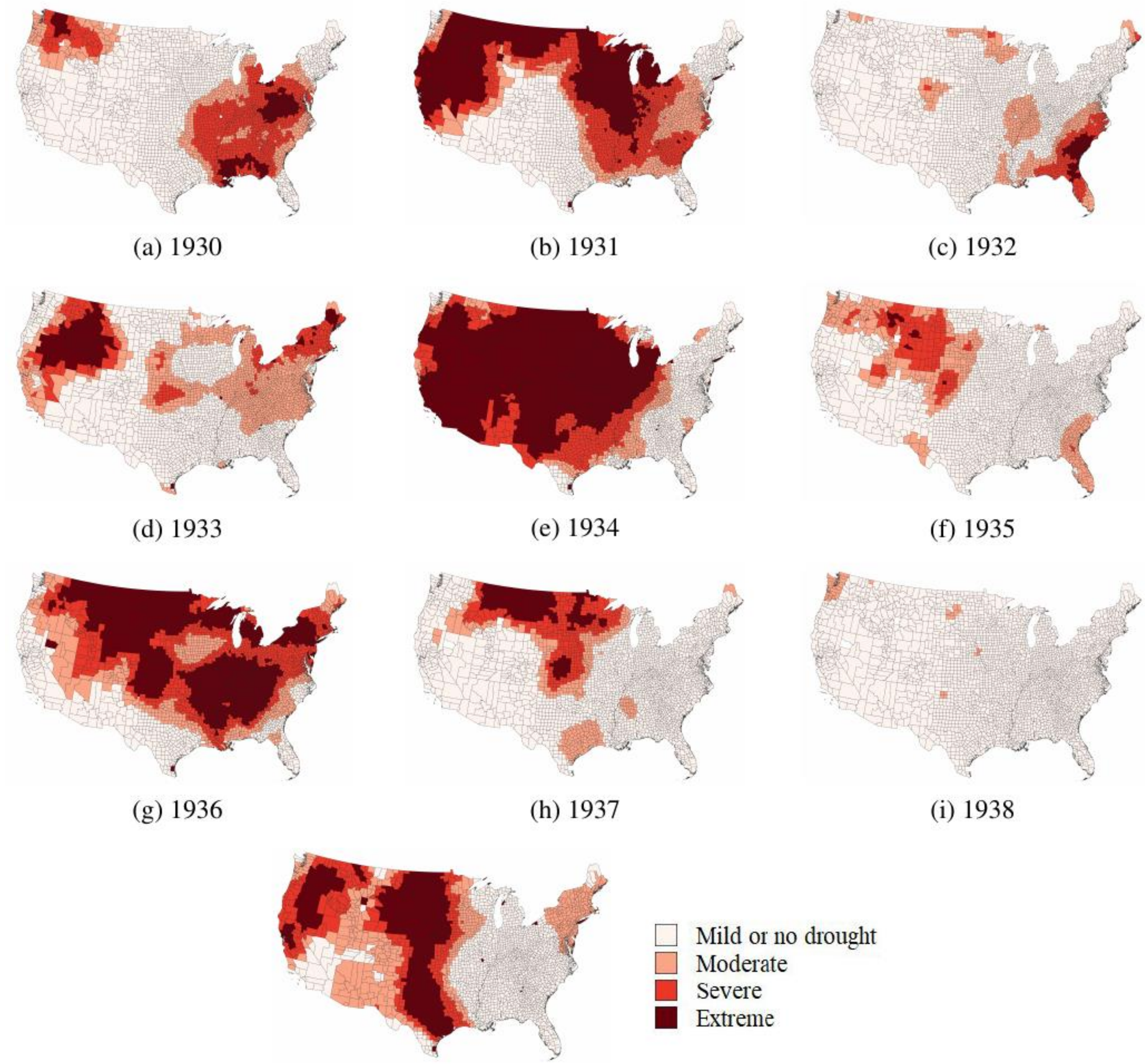


Notes: This figures displays the correlation between drought severity and crop failure in 1934. Each point in this figure represents the average of roughly 150 counties. Drought index values of two (*moderate* drought as shown in Table 2) and higher induced crop failures. Crop failures were assessed at the acre level. For an acre to have *failed* it must have produced no crop. Therefore, overall declines in output were much higher than fraction failed suggests on the surface. Given that crop failures begin an upward trend at a drought index value of two, I use this threshold to define the independent variable of interest for this dissertation: the number of moderate or worse drought years by county over five- and ten-year periods. Data sources: Cook et al. (2010) and Manson et al. (2019).

At an index value of two, a moderate drought as shown in Table 2, crop failures start to increase. I use this threshold to define a measure of multi-year drought intensity below.

Figure 5 displays maps of yearly drought conditions, to show the changing geographic distribution of drought. The initial drought years, 1930 and 1931, impacted the eastern U.S. and the northern mountain west (including Washington, Oregon, Idaho, and Montana). It was not until 1933 that moderate or worse drought conditions appeared and persisted throughout much

Figure 5: Drought by county and year 1930 to 1939



(a) 1930 (b) 1931 (c) 1932

(d) 1933 (e) 1934 (f) 1935

(g) 1936 (h) 1937 (i) 1938

(j) 1939

Notes: This figure displays yearly drought conditions. Drought conditions in 1930 and 1931 mostly did not impact the Great Plains but by 1933 moderate drought had developed on the Plains. These conditions persisted in many counties through 1939 (with the exception of 1938). The worst single year of drought in the decade was 1934. Data sources: Cook et al. (2010) and Manson et al. (2019).

of the Great Plains. The worst single year of drought in North America in the last millennium was 1934 (Cook et al. 2007). In 1934, the drought became exceptionally severe and widespread, and came to center on the Great Plains region. Chapter 5 shows that 1934 was definitive in terms of migration from drought.

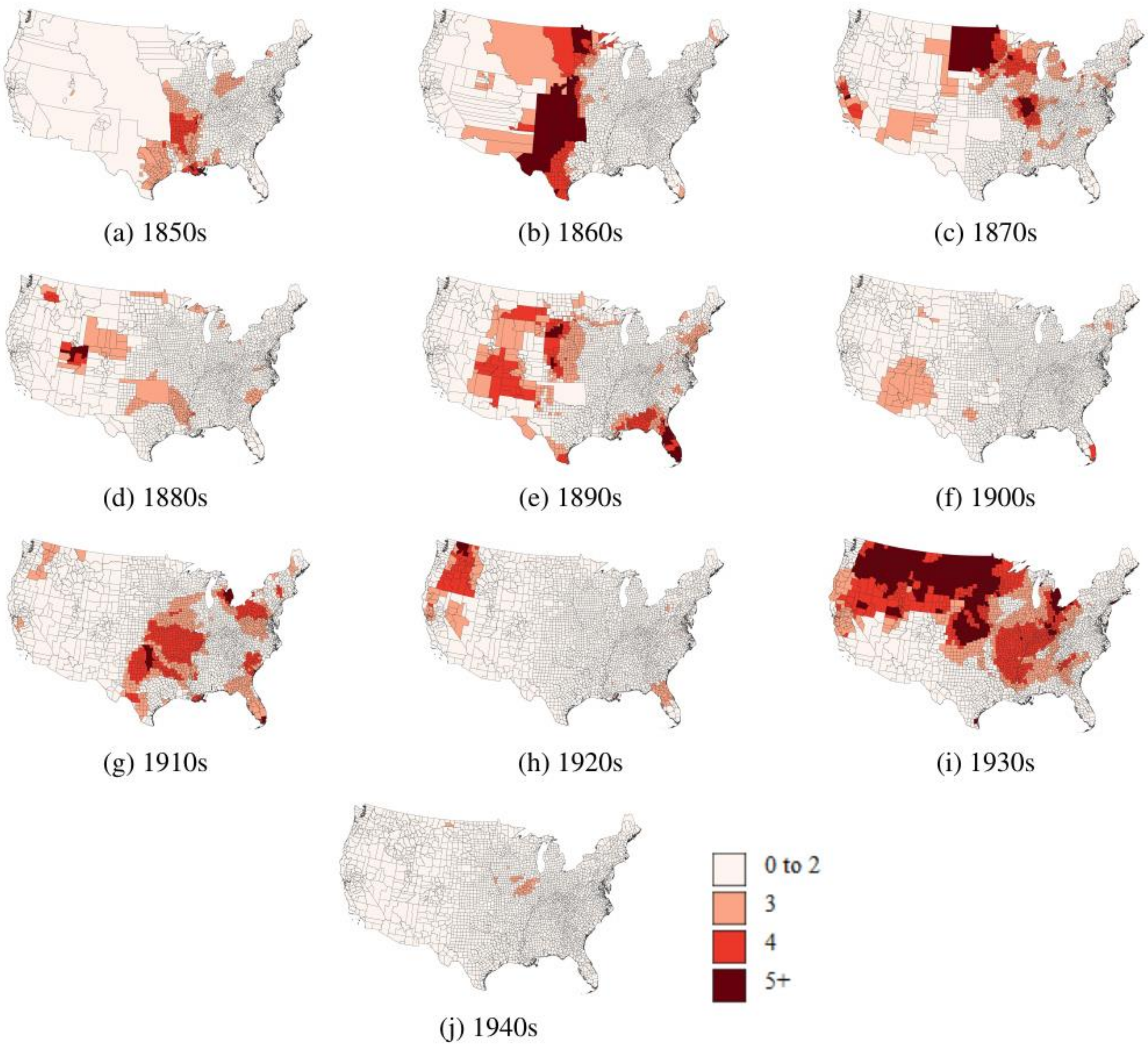
The impact of drought is typically considered on an annual basis, but I observe individuals' locations only in 1930, 1935, and 1940, and observe detailed demographics only in 1930 and 1940. Therefore, much of the analysis of this paper is based on migration during five- and ten-year intervals. Accordingly, I develop a drought variable that measures exposure over multiple years. For the primary independent drought variable, I use the number of moderate or worse drought years experienced by a county over five- and ten-year time horizons. This definition is motivated by the threshold of moderate yearly drought having quantifiable economic impacts as shown in Figure 4.

The count of moderate or worse drought years is a straightforward definition of drought exposure over multiple years, and is based on the established yearly definitions of drought. Nonetheless, other definitions of drought severity over multi-year time horizons (such as the summation of total yearly drought) are also reasonable measures of drought exposure. Measuring multi-year drought with the summation of yearly drought is discussed further in the Appendix. The results of this paper are robust to this alternate measure of drought severity.[28]

With an understanding of what drought means on an annual basis and a variable defined to measure drought over a multi-year period, Figure 6 shows that the 1930s were an outstanding decade by displaying the number of moderate or worse drought years for each decade from the 1850s to the 1940s. Figure 6 shows that it is not unusual in a decade for some counties to suffer

[28] The main complication with measuring multi-year drought as the summation of total yearly drought is that it is not clear how the designated threshold for drought (*mild, moderate, severe,* and *extreme*) translates to the multi-year horizon, and I was not able to find literature on this subject. These thresholds, or being able to describe the impact of drought with a series of indicator variables, are helpful in explaining the impact of drought and showing non-linear impacts. Overall, the number of moderate or worse drought years seemed a more intuitive and straightforward measure of drought exposure when presenting and articulating this research.

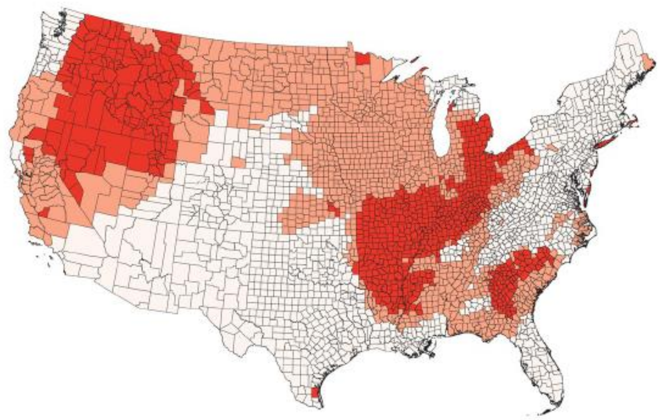
Figure 6: Number of drought years by decade



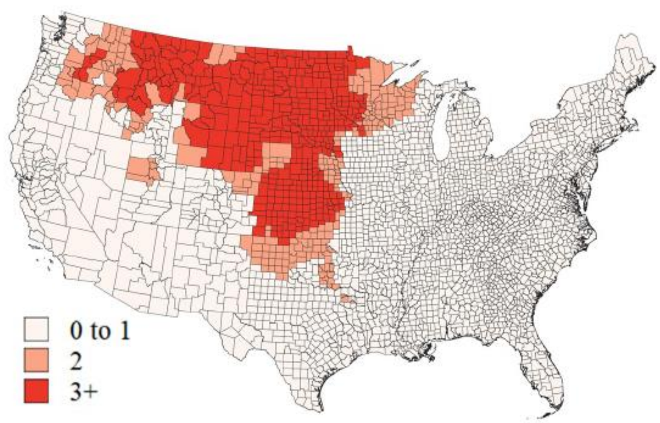
Notes: This figure shows the number of moderate or worse drought years for each decade from 1850 to 1949. The 1930s were the worst decade of drought during this 100 year period and for U.S. history more broadly. The severity of drought during the 1930s motivates the focus of this dissertation on studying the impact of drought during the 1930s. Data sources: Cook et al. (2010) and Manson et al. (2019).

three or four drought years and a few counties to have five or more drought years. But the five or more drought years that stretched from the Great Plains and northern mountain west during the 1930s were exceptional. The 1930s, and the 1860s to a lesser extent, were the worst decades of

Figure 7: Number of moderate or worse drought years in five-year intervals



(a) 1930 to 1934



(b) 1935 to 1939

Notes: This figure shows the number of moderate or worse drought years from 1930 to 1934 and from 1935 to 1939 separately. The drought of the yearly and late 1930s impacted different geographic regions of the United States. The drought of the early 1930s centered on the northwest as well as the Ohio and Mississippi Valleys and the southern United States. The drought of the late 1930s centered on the Great Plains but extended into the northern mountain west and the prairies to the east of the Great Plains. Data sources: Cook et al. (2010) and Manson et al. (2019).

drought through this 100-year time period. The extent of drought in the 1930s motivates the focus of this dissertation when studying the economic impact of drought.

Finally, much of the analysis in this paper distinguishes between the 1930 to 1935 period and the 1935 to 1940 period. The drought of the early and late 1930s impacted different geographic regions as shown in Figure 7. The drought of the early 1930s impacted the northern mountain west, the southeast, and north through the Ohio River Valley. By contrast, the drought of the late 1930s came to center on the Great Plains and a portion of the northern mountain west. We will see that the drought of the early and late 1930s impacted migration in different ways. This difference in migration response to drought might be attributable to differences in the demographics and the underlying climates as is discussed in Chapter 5.

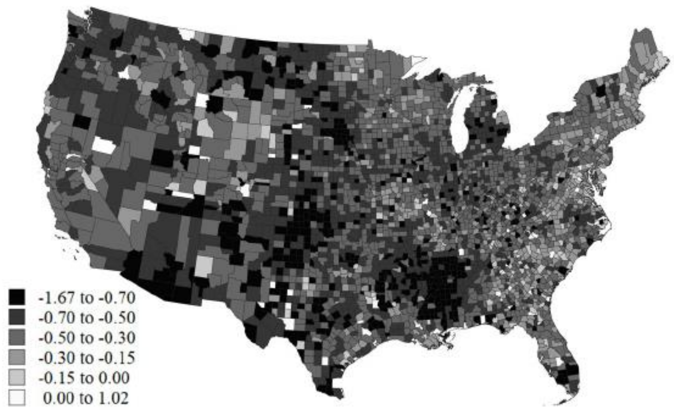
Depression severity, New Deal spending, agriculture, and erosion

I supplement the population census and drought data with a number of other datasets. These datasets include county-level measures of Great Depression severity and New Deal spending, agricultural variables, and soil erosion severity. These variables allow me to control for important events, trends, and variables when studying the relationship between drought and migration.

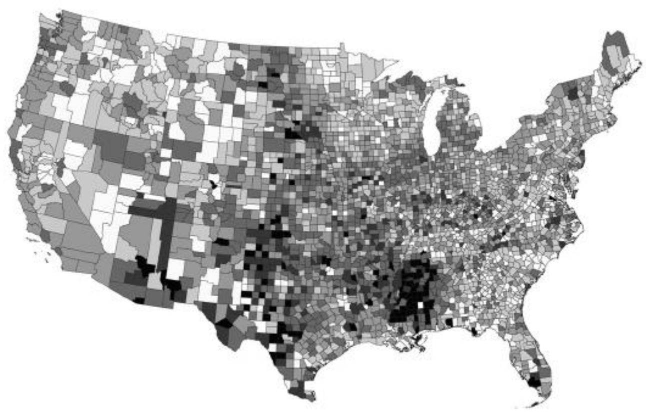
The Great Depression had widespread economic repercussions and the drought likely deepened and lengthened the Depression as discussed in Chapter 5. Therefore, I use data on Great Depression severity and New Deal spending assembled and published by Fishback et al. (2005) to examine the relationship between the Depression and drought. These Great Depression data are the standard data used to study county-level variation in Great Depression severity and New Deal spending.

Figure 8 displays county-level Depression severity in 1933, 1935, and 1939 as measured by *log growth in per capita retail spending*. There was geographic and temporal variation in the intensity of the Depression. Comparing Depression severity in Figure 8 with drought years in Figure 7, there appears to be some correlation between the counties most impacted by drought and the severity of the Great Depression, especially in the second half of the decade (Figure 7.b. and Figure 8.c.). Because no previous research focuses on how drought impacted Depression severity,

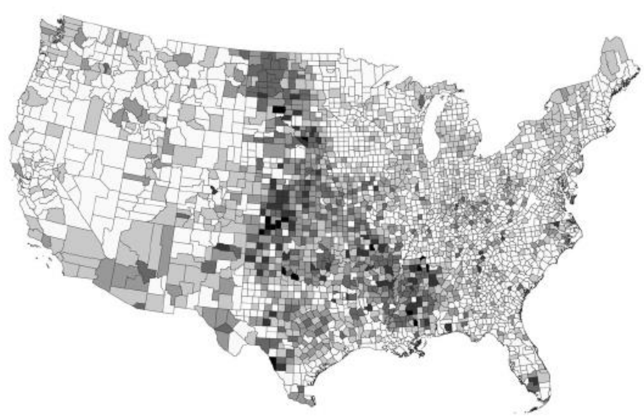
Figure 8: Depression severity: log growth in per capita retail sales



(a) 1929 to 1933



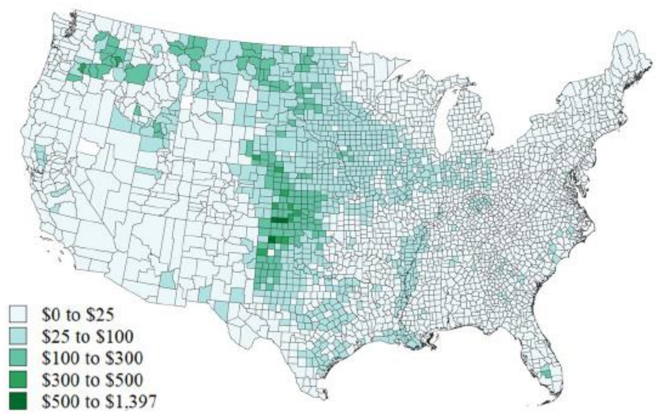
(b) 1929 to 1935



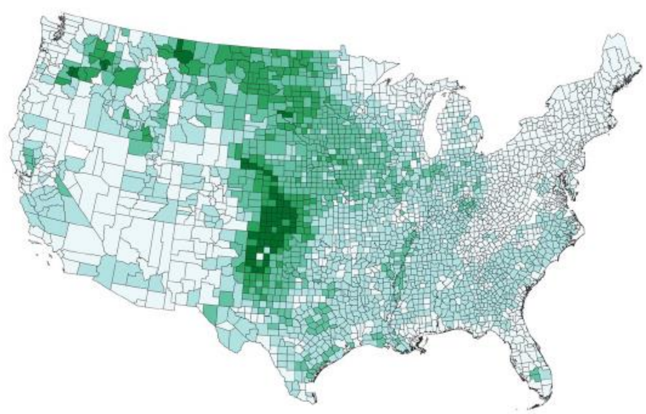
(c) 1929 to 1939

Notes: This figures shows county-level Depression as measured by the log growth of per capita retail sales for different points in time. The trough of the Great Depression was in 1933 as indicated by how dark figure (a) is compared to (b) and (c). By the late 1930s, retail spending had recovered in many areas. But, the Great Plains, the core of the drought region, had a slower recovery. Data sources: Fishback et al. (2005) and Manson et al. (2019).

Figure 9: Agricultural Adjustment Act spending



(a) 1933 to 1935



(b) 1933 to 1937

Notes: This figures shows the county-level allocation of per capita Agricultural Adjustment Act (AAA) spending in 1930 dollars. AAA spending was allocated to the drought region in an effort to help farmers and to establish more sustainable farming practices. The most intensive AAA spending went to the southern Great Plains region of the Dust Bowl. Data source: Fishback et al. (2005) and Manson et al. (2019).

to document the economic impact of drought and, thereby, to motivate why people would want to move away from drought, I estimate the impact of drought on Depression severity in Chapter 5.

In response to the Great Depression, the Roosevelt administration spent billions to revitalize the economy as discussed in Chapter 2. Part of New Deal spending was the Agricultural Adjustment Act (AAA) as displayed in Figure 9. This money was allocated to the drought region and aimed to reorganize farming practices to be more sustainable for farmers and for the environment. Notably, compared to the distribution of the drought, AAA spending was more highly allocated to the south of much of the worst drought conditions. That is, AAA spending was more highly allocated to the Dust Bowl region, which likely suffered the most from the dust storms. The allocation of AAA spending and the ability of the government to potentially mitigate the damage of environmental shocks are important topics that warrant future research but are largely beyond the scope of this dissertation.

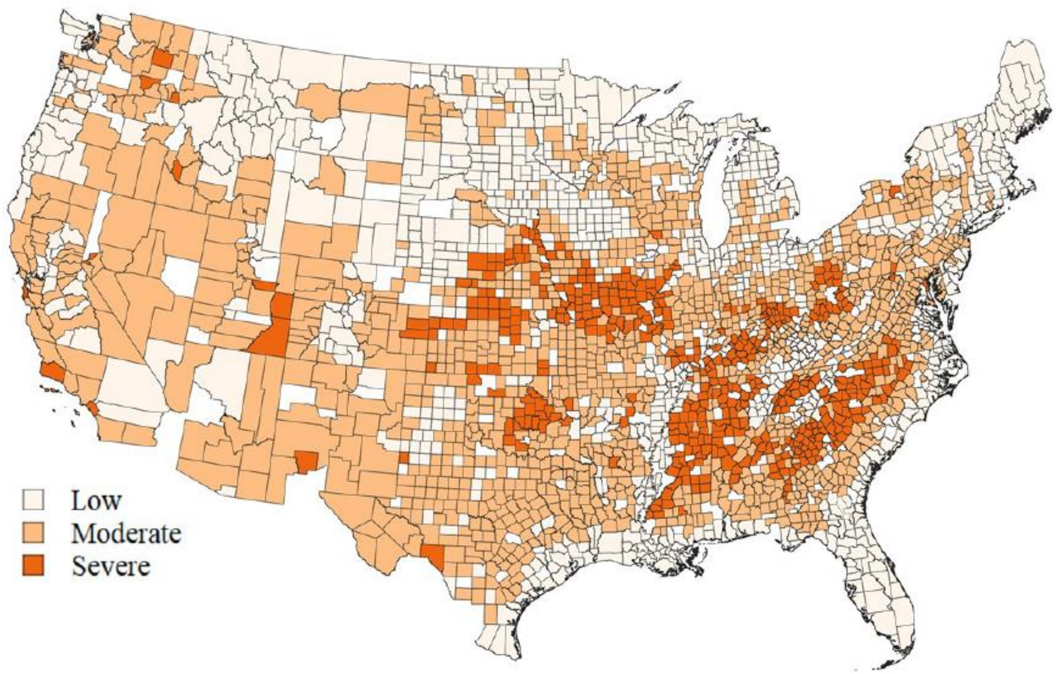
Next, I include U.S. Census of Agriculture data from 1930, 1935, and 1940 (Haines et al. 2018, Manson et al. 2019). The U.S. Census of Agriculture occurs every five years and records production data from the previous year. Historic agricultural census data was digitized by Haines et al. (2018) and geocoded by IPUMS National Historic Geographic Information Systems (NHGIS) (Manson et al. 2019). During the 1930s, the agricultural census recorded extensive information about agricultural production, crop type, demographic information on farmers, and farm equipment.

Finally, soil erosion was an environmental shock related to drought and the Dust Bowl. Soil erosion is the removal of the top layer of soil, which contains a large proportion of nutrients required for productive agriculture (Morgan 2009). To both control for soil erosion and to compare the soil erosion severity to drought severity, I match data on soil erosion to my drought data. Soil erosion evaluations were originally prepared by the Soil Conservation Service (SCS) based on the 1934 Reconnaissance Erosion Survey, among other surveys, and were digitized by Hornbeck (2012).

To see how erosion compared to drought, Figure 10 displays the intensity of soil erosion across the United States.[29] Soil erosion was a widespread problem that was not unique to the Dust

[29] In Figure 10, a county is defined as having severe erosion if greater than 50 percent of its land mass was designated as having severe erosion as defined by Hornbeck (2012). A county is defined as having moderate erosion if greater than 50 percent of its land mass was designated as having moderate erosion or the summation of land with moderate and severe erosion is greater than 50 percent (while moderate and severe land are both less than 50 percent

Figure 10: Soil erosion severity during the 1930s



Note: This figure shows soil erosion severity. Soil erosion was an environmental shock related to drought, wind erosion, and dust storms, but each shock was distinct. Soil erosion is sometimes caused by drought but also is the result of over farming and mono-cropping. Soil erosion was a problem on the Great Plain and across much of the U.S. during the 1930s. Data sources: Hornbeck (2012) and Manson et al. (2019).

Bowl region, the Great Plains, or the region most impacted by drought during the 1930s. Moreover, soil erosion is a broader class of erosion than wind erosion. Wind erosion was acutely problematic on the Plains during the 1930s. Nonetheless, neither local soil erosion nor wind erosion provides an accurate depiction of the severity or frequency of the dust storms because the winds of weather systems swept up eroded soil and carried it hundreds and even thousands of miles.

This is all to say that drought, soil erosion, wind erosion, and dust storm were related but distinct environmental problems. Each of these environmental shocks has different levels of data availability and, to my knowledge, digitized data on wind erosion and dust storm frequency and

individually). All other counties are defined as low erosion. This definition is slightly different from the definition used in Hornbeck (2012, 2020) and the Appendix of this dissertation for ease of display.

intensity across the U.S. are not currently available.[30] Out of these shocks, soil erosion, wind erosion, and dust storms were more driven by human farming activity compared to drought, which was largely an exogenous climate variation.[31] Drought, in many ways, was the overarching environmental shock of the 1930s and was the component of other environmental degradation that resulted from climatic fluctuations rather than human influence.

In summary, this chapter has introduced both the primary and the auxiliary data used in this analysis. The datasets created for this dissertation contain extensive information about individuals in 1930 and 1940, local climate conditions, and other socioeconomic circumstances that enable the detailed study of migration from drought while accounting for covariates. The next chapter details migration patterns across the U.S. and their association with drought conditions. Then, I estimate how local drought intensity impacted migration starting in Chapter 5.

[30] Cunfer (2011) digitizes wind erosion data for the counties at the core of the Dust Bowl.
[31] Nevertheless, there is evidence that the land use and dust amplified the intensity of drought (Cook et al. 2009).

CHAPTER 4

DESCRIPTIVE STATISTICS ON MIGRATION AND DROUGHT

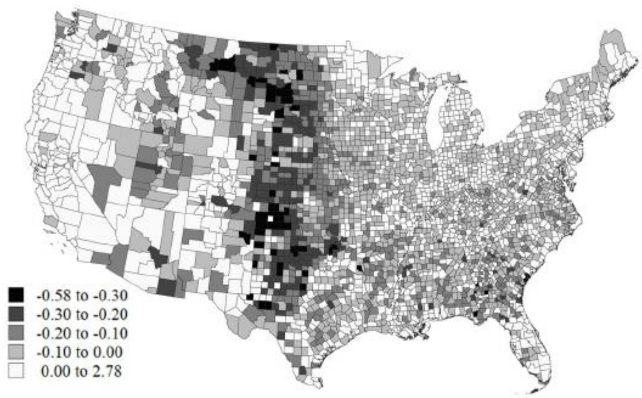
To provide a basis for analyzing the impact of drought on migration, this chapter uses the linked census sample of adult men from 1930 to 1940 (detailed in Chapter 3) to describe county-level migration and migration's relationship to drought. In this chapter, and the dissertation as a whole, a migrant is defined as anyone living in a different county than their county five years before. In this chapter, and Chapter 5, the individual-level census data are aggregated to the county level to study higher-level migration trends.

First, I provide maps of net migration, out-migration, and in-migration from 1930 to 1940 to show the movement of people across the United States. Over the decade, there was a substantial net depopulation across the Great Plains with migrants primarily relocating to more western counties. Next, I disaggregate migration into the periods from 1930 to 1935 and from 1935 to 1940. This disaggregation begins to show the timing of migration from drought as we see a clear relationship between drought and migration in the second half of the 1930s.

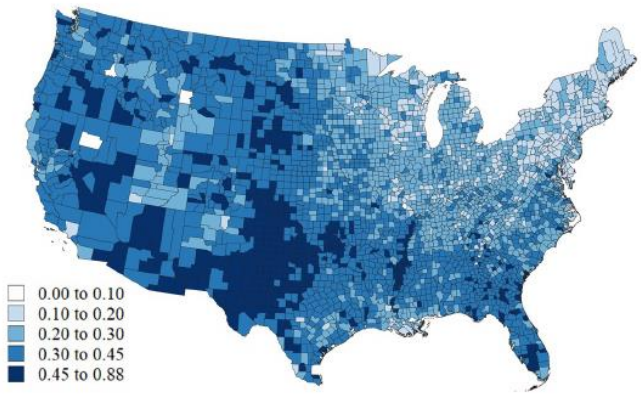
To show migrant flows through the decade, Figure 11 depicts three different measures of migration. First, Figure 11.a. displays net migration from 1930 to 1940. Net migration is defined as the number of migrants who entered a county minus the number of migrants who left over the decade as a fraction of the 1930 population.[32] There was a considerable decline in total population across the Great Plains region as a whole. This observation contributes to recent literature documenting that net declines in population during the 1930s were not unique to the Dust Bowl or

[32] $Net\ Migration_{c(1930-1940)} = (Migrants\ enter\ by\ 1940 - Migrants\ left\ by\ 1940)/Population_{c1930}$

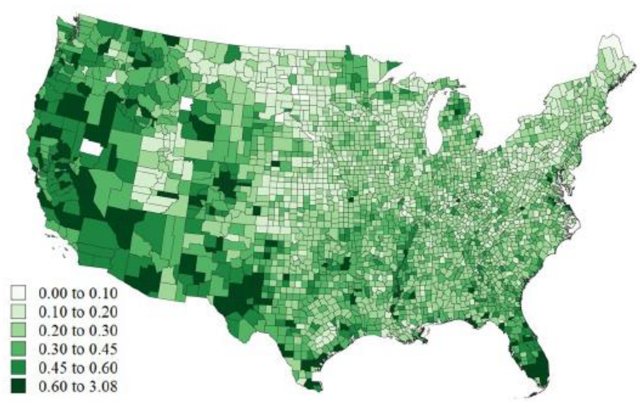
Figure 11: Migration: 1930 to 1940



(a) Net migration



(b) Out-migration



(c) In-migration

Notes: This figure shows migration from 1930 to 1940. The overarching migration trend was a depopulation of the Great Plains region as seen in (a). This finding is an expansion of previous research which focuses on depopulation of the Dust Bowl. The depopulation of the Great Plains was a function of both high out-migration and low in-migration to the region and seen in (b) and (c). Migration measures appear correlated with the number of drought years over the decade. This figure uses the linked sample of adult men (20 to 60 in 1930). Data sources: Ruggles et al. (2019), Manson et al. (2019), and Abramitzky et al. (2020).

the southern Great Plains but common throughout the Great Plains (Hornbeck 2012, Gutmann et al. 2016, Hornbeck 2020).

Figures 11.b. and 11.c. disaggregate net migration into out-migration and in-migration. Out-migration is defined as the fraction of the 1930s population to have left by 1940. In-migration is defined as the number of new residents to have entered as a fraction of 1930s population.[33] The net depopulation of the Plains was a function of both high out-migration and low in-migration. This result is consistent with research on the 20 counties at the core of the Dust Bowl, which shows that much of the net decline in the population for Dust Bowl counties was due to high out-migration and low in-migration (Long and Siu 2018). Still, Figure 11 expands on previous findings by showing that the depopulation of the Plains more broadly was a result of both high out-migration and low in-migration. The dual migration response is important because, often, only the net migration response to environmental shocks is considered. Here, we see that the depopulation of the Plains was a function of both people leaving and few people moving in to replace the migrants.[34]

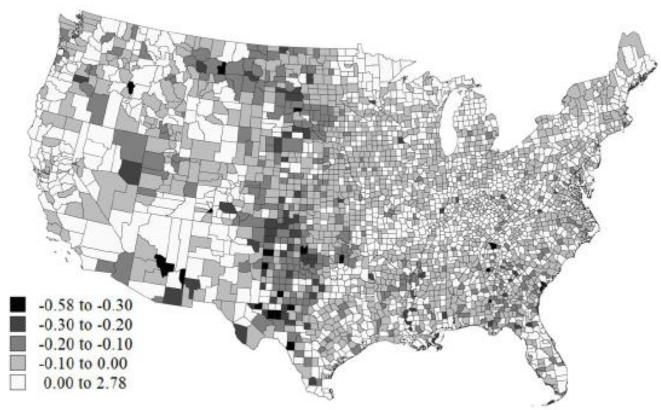
Figure 11 graphically depicts migration over the entire decade and thereby provides a high-level perspective of migration. The detail of the underlying data allows for the disaggregation of migration during the 1930s into two five-year periods. Figures 12 and 13 separately display migration for the 1930 to 1935 period and for the 1935 to 1940 period. In comparing Figures 12 and 13, the first aspect to note is the similarity between migration in the early and late 1930s. In both time periods there was a net decline in the population for the Great Plains driven by

[33] $Out\text{-}Migration_{c(1930-1940)} = (Migrants\ Left_{c(1930-1940)})/Population_{c1930}$

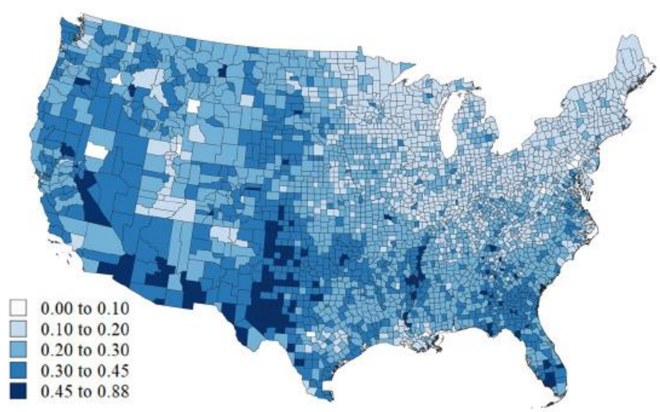
$In\text{-}Migration_{c(1930-1940)} = (Migrants\ Entered_{c(1930-1940)})/Population_{c1930}$

[34] By contrast the same pattern of low in-migration for counties with high out-migration does not hold outside of the drought region. Specifically, while much of the Southwest, and parts of the Pacific Coast, had high out-migration, counties in these regions also had high in-migration.

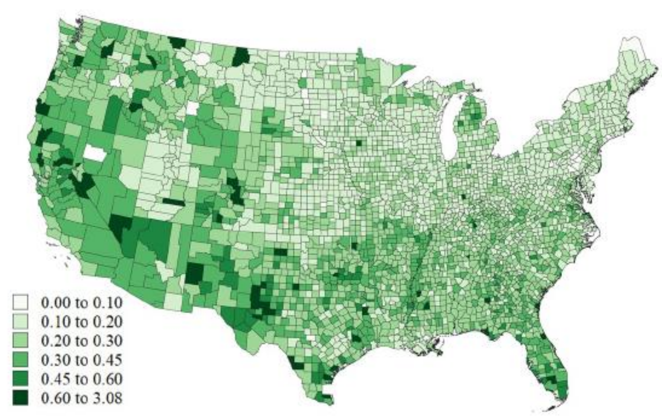
Figure 12: Migration: 1930 to 1935



(a) Net migration



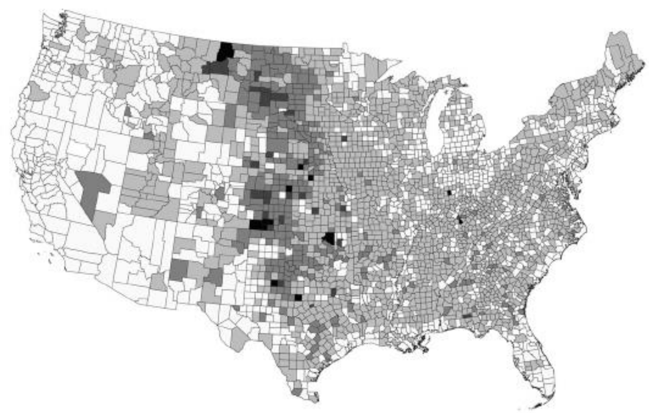
(b) Out-migration



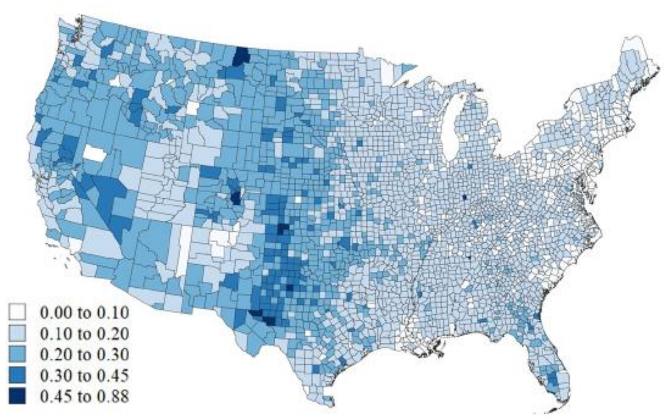
(c) In-migration

Note: This figure shows migration from 1930 to 1935. The migration patterns of the early 1930s look similar to those over the decade as whole as seen in Figure 11. Migration was not clearly correlated with additional drought years in the early 1930s (Figure 7.a). But migration in the early 1930s was correlated with drought severity in 1934 in particular as discussed in Chapter 5. This figure uses the linked sample of adult men (20 to 60 in 1930). Data sources: Ruggles et al. (2019), Manson et al. (2019), and Abramitzky et al. (2020).

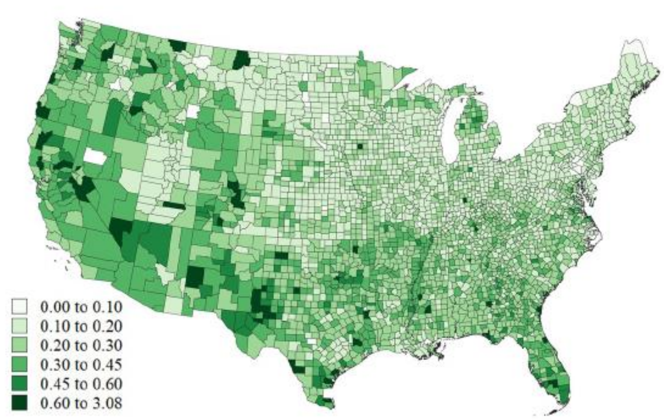
Figure 13: Migration: 1935 to 1940



(a) Net migration



(b) Out-migration



(c) In-migration

Notes: This figure shows migration from 1935 to 1940. The migration patterns of the late 1930s look similar to those over the decade as whole and the migration patterns of the early 1930s (Figure 11 and 12). Migration in the late 1930s appears correlated with drought years in the late 1930s (Figure 7.b.). This figure uses the linked sample of adult men (20 to 60 in 1930). Data sources: Ruggles et al. (2019), Manson et al. (2019), and Abramitzky et al. (2020).

high out-migration and low in-migration.

The second aspect to note in comparing Figures 12 and 13 is the difference in the intensity of migration between the early and late 1930s. Subfigures (b) and (c) are darker in color in Figure 12 compared to Figure 13, indicating that there was more migration in the early 1930s compared to the late 1930s. In fact, in the linked sample, 496 thousand men migrated between 1930 to 1935 while only 295 thousand migrated between 1935 to 1940. But this finding should be considered in the context of the limitations of linked census data. Although I use very conservative linking criteria (as described in Chapter 3), even a low false linkage rate of about ten percent could drive this difference in observed migration rates.[35] The potential for false linkages biasing the migration measures from 1930 to 1935 is addressed and discussed in more detail in Chapter 5.

Given the framework of county-level migration, Table 3 moves to considering migration and drought together. Again, three different migration measures are considered. Now, these migration variables are calculated with regard to the number of drought years each county experienced. Table 3 shows that over the decade, there was a correlation between drought years and migration variables. At the extremes, counties that experienced five or more drought years over the decade witnessed a total decline in population of 6 percent, while counties with two or fewer drought years saw an increase in population of 3 percent on average. The population declines in counties that suffered the most drought years were driven by both higher out-migration and lower in-migration as shown in the second and third rows of Table 3.

[35] The logic behind this statement is as follows. First, if we take the migration rate from 1935 to 1940 as the true migration rate over five-year periods during the 1930s, that means that 11 percent of adult men moved over each five-year time period. Second, if we assume that all false linkages result in a spurious migration, then a false linkage rate of 11 percent will double the observed migration from 1930 to 1935. As the migration rate observed in the linked sample from 1930 to 1935 is 19 percent, it seems likely that something along these hypothetical lines is behind most of the observed higher migration during the 1930 to 1935 period.

Table 3: Migration by number of drought years 1930 to 1940

Drought years	0 to 2	3	4	5+
Fraction of individuals				
Net migration	0.03	0.00	0.01	-0.06
Migrated out	0.29	0.28	0.28	0.31
Migrated in	0.32	0.28	0.27	0.25

Notes: This table shows migration rates by drought years over the entire 1930s. There was net migration from counties with five or more years of drought. The last column in the first row shows that counties with five or more drought years witnessed a 6 percent decline from their 1930 population on average by 1940. This net decline in population was a function of both higher out-migraiton and lower in-migration. This table uses the linked sample of adult men (20 to 60 in 1930) weighted by the inverse probability of linkage. Data sources: Cook et al. (2010), Ruggles et al. (2019), Manson et al. (2019), and Abramitzky et al. (2020).

Table 4: Migration by number of drought years for early and late 1930s

Drought years	0 or 1	2	3+
Panel A: Fraction of individuals 1930 to 1935			
Net migration	0.00	0.01	0.01
Migrated out	0.19	0.18	0.18
Migrated in	0.18	0.17	0.17
Panel B: Fraction of individuals 1935 to 1940			
Net migration	0.01	-0.01	-0.06
Migrated out	0.10	0.14	0.16
Migrated in	0.11	0.13	0.11

Note: This table shows migration rates by drought years separately for the early and late 1930s. There was not a clear relationship between drought years and migration during the early 1930s. There was a description relationship between drought years and migration in the late 1930s. This relationship was driven by higher out-migration from counties with more years of drought. Drought years in this table refer to the number of drought years experienced during the given five-year period. This table uses the linked sample of adult men (20 to 60 in 1930) weighted by the inverse probability of linkage. Data sources: Cook et al. (2010), Ruggles et al. (2019), Manson et al. (2019), and Abramitzky et al. (2020).

As when considering migration by itself, disaggregating migration in terms of drought between the early and late 1930s is informative. Table 4 shows migration with respect to drought years separately for the early and late 1930s, and indicates that the relationship between drought years and migration observed for the decade as a whole was driven by the relationship between drought and migration in the second half of the decade.

The relationship between drought years and migration displayed in Table 4 makes sense when considering the migration maps (Figures 11 through 13) in connection with the distribution of drought in the early and late 1930s (Figure 7). The drought of the early 1930s (measured in terms of drought years) was concentrated to the northern mountain west, the southeast, and north through the Ohio River Valley. These regions did not see large population declines in the early 1930s. Still, while there is no obvious descriptive relationship between drought *years* and migration during the early 1930s, Chapter 5 shows that the intensity of drought in 1934 (the worst year of drought in the last millennium) was correlated with high out-migration and low in-migration in the early 1930s. Furthermore, 1934 set the stage for the impact of drought on migration during the late 1930s. By the middle and late 1930s, drought came to center on the semi-arid Great Plains region that witnessed large population declines.

Tables 3 and 4 show a correlation between drought years and migration over the decade and specifically in the late 1930s. But drought was not randomly distributed. Instead, drought centered on a geographically and demographically distinct region. Therefore, drought and migration should be considering in the context of the covariates in Table 5. There are three main points to take from Table 5. First, the drought region was rural compared to the rest of the United States. This relationship is seen by comparing the fraction of men living in cities and on farms as drought years increased (as in the first two rows) and by comparing average county populations. Second, men living in the drought region were relatively geographically mobile, or at least were more likely to be living in a state other than their birth state and to have been foreign born. Finally, as suggested in Figures 8 and 9, the Depression was more severe in drought counties and New

Table 5: 1930 county demographics by drought years from 1930 to 1940

Drought years	0 to 2	3	4	5+
Fraction				
In city	0.13	0.11	0.08	0.08
On farm	0.42	0.49	0.54	0.54
Farms mortgaged	0.35	0.43	0.44	0.56
Men employed	0.94	0.94	0.95	0.95
White	0.85	0.87	0.90	0.97
In birth state	0.68	0.70	0.69	0.46
Foreign born	0.08	0.06	0.06	0.14
Average				
Population	12,889	11,222	7,975	6,500
Occupational score	18.2	17.9	17.3	16.9
Age	37.2	37.6	37.8	37.7
Per capita				
Growth in spending	0.03	-0.04	-0.06	-0.09
Public works and relief spending	$132	$120	$128	$161
AAA spending	$41	$82	$86	$189

Notes: This table shows average of demographic variables based on the drought exposure from 1930 to 1939. Multiple covariates to migration varied with drought exposure. The region most impacted by drought had a smaller fraction of the population in cities, a higher fraction on farms, and relatively low county populations. People in the drought counties were more likely to be living outside of their birth state and more likely to be foreign born. Finally, AAA spending was highly allocated to drought counties. This table uses the linked sample of adult men (20 to 60 in 1930) weighted by the inverse probability of linkage. County populations are weighted to be representative of total county population of adult men (20 to 60). Data sources: Fishback et al. (2005), Cook et al. (2010), Ruggles et al. (2019), Manson et al. (2019), and Abramitzky et al. (2020).

Deal spending, especially the Agricultural Adjustment Act (AAA), was allocated to drought counties. In light of the differences between drought and non-drought counties, it is possible that underlying migration rates among men with different backgrounds led to the descriptive differences in migration rates between drought and non-drought areas rather than drought itself.

This chapter examines descriptive relationships between drought and migration, and provides an idea of when and where migration from drought occurred. Nonetheless, from the descriptive statistics, the role of drought in migration is not clear, as there are numerous covariates to considering when evaluating the impact of drought on migration. These confounding factors necessitate the more formal estimation of the relationship between drought and migration in the next chapter.

CHAPTER 5

ECONOMIC RESPONSES TO DROUGHT 1: DROUGHT, MIGRATION, AND THE GREAT DEPRESSION

The 1930s drought was an environmental disaster that coincided with a large depopulation of the Great Plains region. But we know little about the influence of drought on migration decisions. Previous research on migration from environmental degradation during the 1930s is focused on the Dust Bowl region, mostly does not seek to identify the impact of dust storms (or variables related to drought and environmental degradation) from other variables that impacted migration, and largely does not study the timing of migration.

This chapter expands on previous research by using county-level variation in drought years to study net migration, out-migration, and in-migration over the decade as a whole and for the 1930 to 1935 and 1935 to 1940 periods, separately. Moreover, to quantify the economic impact of drought and, thereby, empirically document the geographic disparities induced by drought, this chapter also examines how drought impacted Depression severity.

To study the relationship between migration and drought, I use the linked census dataset of adult males from 1930 to 1940 in connection with the drought data described in Chapter 3. The goal of this chapter is to analyze county-level migration. Therefore, I aggregate the linked data set to county-level measures of migration. Additionally, because of concerns for false linkages impacting the results, I also use the full count 1930 and 1940 censuses to compute net migration measures.[36] I estimate the impact of drought on migration measures using Ordinary Least Squared (OLS) regressions, which control for county-level covariates and include state fixed effects.

I find that additional drought years at the county-level were correlated with decreased net migration (that is, drought counties lost population), compared to similar counties from within the same state from 1930 to 1940. Over the decade as whole, this depopulation was driven by increased out-migration from drought counties. Furthermore, the detailed data allow me to study migration between 1930 to 1935 and 1935 to 1940, separately, which enables the analysis of the timing of migration. From this disaggregation, we see modest migration away from drought counties in the early 1930s.[37] Yet, drought severity in 1934 specifically, the worst single-year of drought in the last millennium, was highly correlated with both higher out-migration and lower in-migration in the early 1930s. Counties that experienced extreme drought conditions in 1934 witnessed an 8.1 percentage point decline in their population between 1930 and 1935 compared to similar counties that experienced mild or no drought. The relationship between drought and migration continued through the late 1930s.

These results provide the most complete picture of how drought impacted migration during the 1930s to date. I expand on previous research by showing that variation in drought impacted migration when considering the U.S. as a whole. That is, the depopulation in response to negative environmental conditions was not a phenomenon unique to the Dust Bowl. This finding is consistent with recent literature showing that migration from environmental shocks was much more widespread than the historic core of the Dust Bowl (Hornbeck 2012, Gutmann et al. 2016,

[36] I restrict the full count censuses to men aged 20 to 60 in 1930 so that the demographics are the same for the full count data as for the linked sample.

[37] The migration response to drought in the early 1930s must be consider in the context of the linked census sample and false linkages potentially impacting the regression coefficients as is discussed in detail in the results section of this paper.

Hornbeck 2020). These findings are an important step towards a more comprehensive understanding of how environmental shocks influenced the geographic population distribution of the United States.

The result of this chapter, that migration away from drought started in earnest in 1934, contributes to our understanding of the importance of persistence, severity, and underlying demographics in migration from climate shocks. This result is consistent with historical literature on the Dust Bowl, which argues that most migration happened later in the decade (Riney-Kehrberg 1989). Furthermore, this result is consistent with historical records from popular destinations, which document a large influx of migrants starting in 1934 (Taylor and Vaset 1936, Hoffman 1938). Understanding the timing of migration in the context of the severity and length of drought, and the demographics and typical climate of the impacted area, helps to explain what convergence of factors leads to mass migration from environmental shocks. In the 1930s, it took an exceptionally bad drought year that centered on a semi-arid region with a relatively mobile population to induce large changes in migration trends.

Finally, in terms of migration and drought, I show that the depopulation of drought counties in the middle and late 1930s was a function of increased out-migration and decreased in-migration. Again, while this is a new finding in the context of the widespread drought, this finding is consistent with literature on the Dust Bowl, which shows that population declines arose from both increased out-migration and decreased in-migration (Long and Siu 2018). This finding is important because migration studies focus on net or gross migration and we tend to think of migration responses to shocks in terms of push factors. In the 1930s, both push and pull factors emanating from drought impacted migration.

This chapter principally provides the basis of estimating the impact of drought on migration. But because there is little research on the economic impact of the widespread drought (even aside from migration), this chapter also estimates the impact of drought on Depression severity. Droughts often impact agriculture, industrial production, human health, and the overall habitability of locations.[38] Nonetheless, the impact of drought depends on the economic and social structure of the affected area (including the agricultural and industrial workforce), the level of technology (such as irrigation and air conditioning), and the underlying demographics and social structure (average education, wealth, age, etc.).[39] Therefore, droughts have different repercussions depending on the characteristics of the impacted area. To show the economic impact of drought and the spatial disparities resulting from drought, this chapter analyzes the relationship between county-level drought and Depression severity.

To study the economic impact of drought, I use a dataset on Depression severity described in Chapter 3 (Fishback et al. 2005). The outcome variable of interest is the *log growth in per capita retail sale from 1929 to 1939*. This variable is a standard measure of local variation in Depression severity in the literature. I estimate the impact of additional drought years on Depression severity with OLS regressions that control for county covariates and state fixed effects.

I find that drought years impacted Depression severity for the decade as a whole. Specifically, counties that suffered five or more drought years experienced 8.6 log percentage points lower growth in per capita retail spending over the decade. This was a large decline in retail

[38] For recent literature on the agricultural impact of climate shocks related to drought see Schlenker and Roberts (2006), Deschenes and Greenstone (2007), Libecap and Steckel (2011), Bleakley and Hong (2017), and Feng et al. (2017). For recent literature on non-agricultural impacts of drought (mostly related to heat) see Barnett and Adger (2007) Jacob and Moretti (2007), Deshchenes and Moretti (2009), Hsiang (2010), Dell et al. (2012), and Barreca et al. (2016).

[39] For the changing impact of climate shocks based on technology change see Hornbeck and Keskin (2014) and Barraca et al (2016). For research on the heterogeneous impact of climate shocks by demographics see Chapter 6, Kleemans (2015), and Bazzi (2017).

spending as, on average, counties had returned to their 1929 spending levels by 1939. Additionally, I disaggregate these results between *rural* and *urban* counties to show how drought differentially impacted sectors of the economy.[40] Drought had its most pronounced impact on rural counties but it also impacted retail spending in urban counties.

These findings contribute to our understanding of how drought impacted the economy at a particular time and place, and are consistent with literature outside of the 1930s on the impact of drought on agricultural and non-agricultural sectors. Drought is a deviation in climate variables, and because average climate conditions are central to agricultural planning and planting, droughts have large impacts on crops and crop yields.[41] Correspondingly, the drought had its largest impact on rural (and largely agricultural) counties. While the impact of drought on the agricultural sector is perhaps most obvious, and largest during the 1930s, droughts (and specifically the heat associated with droughts) have considerable impact on the economy outside of their impact on the agricultural sector (Hsiang 2010, Dell et al 2012). Abnormally high heat impacts human health and industrial production through heat stress and strokes. The impact of heat is pronounced in economies (such as the 1930s U.S.) without the widespread adoption of the air conditioner (Barreca et al 2016). The result of this chapter, that drought also affected urban counties, suggests that the 1930s drought impacted the economy beyond its impact on the agricultural sector. As such, the migration response from both city and non-city origin locations is studied in Chapter 6.

In total, this chapter analyzes how drought impacted migration at the county-level. In doing so, this chapter shows that drought was associated with increased out-migration and decreased in-

[40] Rural counties are defined as counties with greater than 50 percent of their population living outside IPUMS designated cities in 1930. Urban counties are defined as counties with greater than 50 percent of their population living in cities in 1930.

[41] Even so, the impact of drought on the agricultural sector depends not only on the severity of the drought but the species and variety of crops and the level of technology in the impacted area (Hornbeck and Keskin 2014).

migration starting in 1934 and continuing through the second half the decade. These findings provide a more complete picture of the relationship between migration and drought. In particular these findings contribute to a recent movement in the literature expanding on the historic focus of the Dust Bowl. Moreover, these findings are among the first to discuss the timing of environmental migration from a persistent shock. This chapter sets the stage for more detailed analysis of who drought migrants were, where they went, and how they fared, which are the topics of Chapters 6 and 7.

Empirical framework

I estimated the impact of drought on migration using a linear regression specified in Equation 1. The primary data used in this chapter are the linked census data (described in Chapter 3) aggregated to the county level. Because of concerns for false linkages, I supplement the linked census data with full count census measures when possible, as described below. I estimate the relationship between drought and three different measures of migration. First, net migration measures the change in total population over the time period. I estimate net migration with both the full count censuses and the linked sample. Second, out-migration measures the fraction of a county's population to have left over a given time period. Finally, in-migration measures the number of new residents to have entered a county as a fraction of the county's original population.[42]

[42] For example, for the period from 1930 to 1940 the migration measures using the linked are defined as follows:
$Net\ Migration_{c(1930-1940)} = (Migrants\ enter\ by\ 1940_c - Migrants\ left\ by\ 1940_c)/Population_{c1930}$
$Out\text{-}Migration_{c(1930-1940)} = (Migrants\ Left_{c(1930-1940)})/Population_{c1930}$
$In\text{-}Migration_{c(1930-1940)} = (Migrants\ Entered_{c(1930-1940)})/Population_{c1930}$
For the 1930 to 1935 and 1935 to 1940 these variables are defined in the same way but over the designated time period. Furthermore, I also estimate net migration using the full count censuses to calculate the number of men in the relevant age range in each county in 1930, 1935, and 1940:
$Net\ Migration_{c(1930-1940)} = (Population_{\ c1940} - Population_{\ c1930})/Population_{c1930}$

(1) $M_c = \alpha + \beta_1 D_c + \theta_1 X_{c1930} + \gamma_{s1930} + \varepsilon_c$

Formally, the outcome variable M_c measures migration at the county-level over five- and ten-year time periods. Each migration variable is regressed on a vector of indicator variables for the number of drought years for each county (D_c), a vector of county characteristics (X_{c1930}), state fixed effects (γ_{s1930}), and an error term (ε_c). The vector of county characteristics (X_{c1930}) includes: average age, fraction of population white, fraction living in a city, fraction living in their birth state, fraction foreign born, fraction of men employed, fraction of men employed in farming, and the county population. The subscripts and descriptions in Equation 1 include 1930 as the year in which county controls and state fixed effects are included. For regressions on the 1935 to 1940 period, county controls and state fixed effects are included based on 1935 county and state.[43]

I estimate Equation 1 for three different time periods in order to evaluate how the impact of drought on migration changed over the decade. First, I estimate the impact of drought years on migration over the decade as a whole. Then, I separately estimate the impact of drought years on migration for the early and late 1930s. Finally, for regressions that use variables constructed with the linked sample of men, I weight the regressions by the inverse of the average probability that men in the county were linked between censuses.[44]

This alternate measure of migration is a robustness check to net migration measured with the linked census sample. The problem with this measure of net migration is that it does not account for county-level deaths. I do not believe county-level deaths for specific age ranges are easily available during the 1930s. Nonetheless, the estimates using this alternate measure of net migration are largely consistent with the net migration as measured by the linked sample.

[43] That is, for regressions concerning the 1935 to 1940 period, I calculate county measures based on the demographics of the 1935 population when possible (average age, fraction white, fraction in city, fraction in birth state, fraction foreign born, and population. For variables that I do not observe in 1935 (fraction employed, and fraction employed in farming), I use the counties 1930 values as controls.

[44] This procedure is equivalent to weighting an individual-level regression by the inverse probability of each observation being linked.

Table 6: County-level migration from drought 1930 to 1940

	(1) Net migration	(2) Net migration	(3) Out-migration	(4) In-migration
3 drought years (1930 to 1939)	-0.021	-0.026**	0.009**	-0.016
	(0.012)	(0.013)	(0.005)	(0.012)
4 drought years (1930 to 1939)	-0.028*	-0.024	0.016**	-0.008
	(0.015)	(0.015)	(0.007)	(0.016)
5+ drought years (1930 to 1939)	-0.021	-0.020	0.017**	-0.003
	(0.019)	(0.017)	(0.008)	(0.016)
Sample	Full count	Linked sample	Linked sample	Linked sample
Observations	3,073	3,073	3,073	3,073

Standard errors clustered by 1930 state in parentheses

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

Notes: This table displays the results of regressing migration measures on drought years. The first column uses the total population change of men (aged 20 to 60) for each county calculated with the full count censuses. Columns 2, 3, and 4 use the linked sample of men weighted by the inverse probability of linkage. The last coefficient in column 1 estimates that counties with five or more drought years witnessed a net population decline of 2.1 percentage points compared to similar non-drought counties. That is, counties with more drought years witnessed declines in population. Most clearly, the net migration away from drought counties was driven by higher out-migration (column 3). Regressions include state fixed effects and county-level controls as detailed in Equation 1.

Migration results

The results on the impact of drought on migration over the entire decade are displayed in Table 6. Column 1 uses the full count censuses and displays that there was a negative relationship between the number of drought years over the decade and the net migration. That is, as drought years increased the total population of a county decreased. The negative relationship between drought and population declines is at the margin of statistical significance using both the full count census data (column 1) and the linked census data (column 2).

Net migration is a function of out-migration and in-migration and the linked census data enable the disaggregation of the net migration result. Column 3 shows that there was a statistically significant relationship between droughts years and county-level out-migration, meaning that as drought years increased for a particular county, so did the fraction of people who left that county. On the other hand, column 4 shows that, when considering the decade as a whole, there does

Table 7: County-level migration from drought 1930 to 1935

	(1) Net migration	(2) Net migration	(3) Out-migration	(4) In-migration
2 drought years (1930 to 1934)	-0.010	-0.008	0.002	-0.005
	(0.010)	(0.010)	(0.006)	(0.009)
3+ drought years (1930 to 1934)	-0.027**	-0.012	0.011	-0.001
	(0.012)	(0.011)	(0.007)	(0.010)
Sample	Full count	Linked sample	Linked sample	Linked sample
Observations	3,073	3,073	3,073	3,073

Standard errors clustered by 1930 state in parentheses

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

Notes: This table displays the results of regressing migration measures on drought years from 1930 to 1934. The first column uses the total population change of men (aged 20 to 60) for each county calculated with the full count censuses. Columns 2, 3, and 4 use the linked sample of men weighted by the inverse probability of linkage. The last coefficient in column 1 estimates that counties with three or more drought years witnessed a net population decline of 2.7 percentage points from 1930 to 1935 compared to similar non-drought counties. This relationship does not hold when using the linked census data, possibly because of false linkages biasing the results towards zero. Regressions include state fixed effects and county-level controls as detailed in Equation 1.

not appear to be a relationship between drought years and in-migration. Note, however, that this in-migration measure only indicates that people were not avoiding counties with more drought compared to other counties with less drought *within* the same state. We saw in the descriptive statistics of Chapter 4 that there was low in-migration to the drought region as a whole. Moreover, the results using the linked sample should be interpreted in the context of the possibility of false positives biasing the coefficients downward. Overall, Table 6 shows there was a strong positive relationship between out-migration and drought years when considering the decade as a whole.

Disaggregating the migration response between the early and late 1930s is informative to understanding how drought impacted migration. To start to study the impact of drought on migration separately for the early and late 1930s, Table 7 displays the migration response to drought in the early 1930s. Table 7 column 1 shows that there was some depopulation of drought counties compared to non-drought counties within the same state when the relationship is measured with the full count census. But this relationship becomes smaller in magnitude and

Table 8: County-level migration from drought severity in 1934

	(1) Net migration	(2) Net migration	(3) Out-migration	(4) In-migration
Moderate drought 1934	-0.028***	-0.015*	0.011	-0.004
	(0.010)	(0.008)	(0.009)	(0.014)
Severe drought 1934	-0.034*	-0.042**	0.044**	0.003
	(0.019)	(0.020)	(0.022)	(0.012)
Extreme drought 1934	-0.081***	-0.098***	0.048***	-0.050***
	(0.023)	(0.020)	(0.016)	(0.018)
Sample	Full count	Linked sample	Linked sample	Linked sample
Observations	3,073	3,073	3,073	3,073

Standard errors clustered by 1930 state in parentheses

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

Notes: This table displays the results of regressing county-level migration measures on drought severity in 1934. The first column uses the total population change of men (aged 20 to 60) for each county calculated with the full count censuses. Columns 2, 3, and 4 use the linked sample of men weighted by the inverse probability of linkage. The last coefficient in column 1 estimates that counties with extreme drought in 1934 witnessed a net population decline of 8.1 percentage points from 1930 to 1935 compared to similar non-drought counties. Overall, there was a clear and strong statistical relationship between migration measures in the early 1930s and drought severity in 1934. This relationship holds both with the full count migration measure and linked sample migration measures. The net migration from counties that suffered the worst drought in 1934 was a function of both higher out-migration and lower in-migration (columns 3 and 4). Regressions include state fixed effects and county-level controls as detailed in Equation 1.

insignificant when the linked census data is used in column 2, indicating that false linkages or a non-representative linked sample are biasing the results from 1930 to 1935. Therefore, while column 1 of Table 7 shows that there was a relationship between drought years and migration during the early 1930s, I am not able to disaggregate this result into impacts on out- and in-migration given the current limitations of linked census data.[45]

The nature and intensity of yearly drought is important to consider, and elucidates how drought impacted migration in the early 1930s. As displayed in Figure 5 of Chapter 3, 1934 was the worst year of drought in the decade. To show how drought severity in 1934 specifically

[45] False linkages are most problematic for the 1930 to 1935 compared to both the 1930 to 1940 and the 1935 to 1940 periods. False linkages are not a problem at all for the 1935 to 1940 period because location in both 1935 and 1940 come from the 1940 census. Moreover, this means that when evaluating migration from 1930 to 1940 only the portion of the moves that occurred from 1930 to 1935 are subject to false linkages.

impacted migration in the early 1930s, Table 8 displays the results of regressing county-level migration measures on 1934 drought severity. Column 1 shows that drought severity in 1934 was highly correlated with net migration from 1930 to 1935. Counties that suffered extreme drought conditions in 1934 witnessed a decline in total population of 8.1 percent compared to similar counties with no drought or mild drought. Column 2 shows that this relationship holds in the linked census dataset, and columns 3 and 4 disaggregate the result into out- and in-migration. The depopulation of drought counties was a function of increased out-migration and decreased in-migration (at least in the case of extreme drought). The results of Table 8 indicate the severity of drought in 1934 was central to migration from drought during the early 1930s.

The migration response to drought continued through the late 1930s as shown in Table 9. Column 1 shows that there was a negative and statistically significant relationship between net migration and drought years in the late 1930s. For the late 1930s, there is no concern about false linkages biasing the migration results because 1935 locations are from the 1940 census. As such, the estimated coefficients between the full count and linked sample (columns 1 and 2) are similar. Moreover, the similarity of the results in columns 1 and 2 are reassuring that selection into linkage is not a large problem.[46] Moreover, the consistency between columns 1 and 2 (especially for counties with three or more drought years) suggests that the estimates for out- and in-migration are close to their true values for the 1935 to 1940 period. Columns 3 and 4 show that the net migration away from drought in the late 1930s was a function of increased out-migration and decreased in-migration. These results are discussed in the context of previous literature in the Discussion section.

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[46] Some differences in "net-migration" as estimated by county population tabulations from the full count census and the linked sample are expected. I am not able to account for deaths in the relevant age range at the county level in the full count tabulations. Therefore, if drought was correlated with mortality at the county level, then the results in column 1 overstate net migration away from drought counties.

Table 9: County-level migration from drought 1935 to 1940

	(1) Net migration	(2) Net migration	(3) Out-migration	(4) In-migration
2 drought years (1935 to 1939)	-0.027**	-0.016	0.003	-0.012
	(0.012)	(0.013)	(0.004)	(0.013)
3+ drought years (1935 to 1939)	-0.039*	-0.034*	0.018**	-0.017
	(0.020)	(0.020)	(0.008)	(0.019)
Sample	Full count	Linked sample	Linked sample	Linked sample
Observations	3,073	3,073	3,073	3,073

Standard errors clustered by 1935 state in parentheses

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

Notes: This table displays the results of regressing county-level migration measures on drought years from 1935 to 1939. The first column uses the total population change of men (aged 20 to 60) for each county calculated with the full count censuses. Columns 2, 3, and 4 used the linked sample of men weighted by the inverse probability of linkage. The last coefficient in column 1 estimates that counties with three or more drought years witnessed a net population decline of 3.9 percentage points from 1935 to 1940 compared to similar non-drought counties. Overall, there was a statistically significant relationship between drought years and migration during the late 1930s. This relationship holds both with the full count and linked sample migration measures. The net migration from counties that suffered the more drought years in the late 1930s was a function of both higher out-migration and lower in-migration (columns 3 and 4). Regressions include state fixed effects and county-level controls as detailed in Equation 1.

Depression severity

I document the impact of drought on Depression severity using a linear regression as specified in Equation 2.

(2) $ln(G)_c = \alpha + \beta_1 D_c + \theta_1 X_{c1930} + \gamma_{s1930} + \varepsilon_c$

The outcome $ln\ (G_c)$ is a continuous variable measuring county-level growth in retail sales per capita measured from 1929 to 1939. The growth in retail sales per capita variable is from a dataset on Depression severity described in Chapter 3 (Fishback et al. 2005). The retail sales data are the standard measures of local variation in Depression severity in the literature. Growth in retail sales per capita is regressed on a vector of indicator variables for the number of drought years for each county (D_c), a vector of county characteristics in 1930 (X_{c1930}), state fixed effects (γ_{s1930}), and

Table 10: Drought years and Depression severity

	(1) Growth in per capita retail sales 1929 to 1939	(2) Growth in per capita retail sales 1929 to 1939	(3) Growth in per capita retail sales 1929 to 1939
3 drought years (1930 to 1939)	-0.057***	-0.061***	-0.022
	(0.020)	(0.021)	(0.019)
4 drought years (1930 to 1939)	-0.073***	-0.076***	-0.036
	(0.023)	(0.024)	(0.026)
5+ drought years (1930 to 1939)	-0.086***	-0.090**	-0.041*
	(0.031)	(0.035)	(0.021)
Sample	All counties	Rural counties	Urban counties
Observations	3,018	2,691	323

Standard errors clustered by 1930 state in parentheses

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

Notes: This table displays the results of regressing Depression severity on drought years from 1930 to 1939. As drought years increased, so did Depression severity as measured in 1939. The last coefficient in column 1 estimates that counties with five or more drought years witnessed 8.6 log percentage points less growth in per capita retail spending compared to similar non-drought counties. Columns 2 and 3 disaggregate the results between rural and urban counties to show that the drought impacted retail spending most dramatically in rural counties but also impacted urban counties. Rural counties are defined as counties with greater than 50 percent of the population living outside IPUMS designated cities. Urban counties are defined as counties with greater than 50 percent of the population living in IPUMS designated cities. Regressions include state fixed effects and county-level controls.

an error term (ε_c).[47] Further details on the right-hand-side variables are discussed in the context of Equation 1.

The results for estimating Equation 2 are reported in Table 10. The primary result (column 1) is that growth in per capita retail sales in counties that experienced five or more drought years was 8.6 log percentage points lower than similar counties that experienced two or fewer drought years. This constituted a large impact on growth in per capita retail spending as the average county-level growth in per capita retail spending was -2.2 log percentage points over the decade.

The impact of drought was not uniformly spread across the economy. Instead, drought disproportionately impacted retail spending in rural counties compared urban counties (columns 2

[47] As in Equation 1, the vector of county characteristics (X_c) includes: average age, fraction white, fraction living in a city, fraction living in their birth state, fraction foreign born, fraction of men employed, fraction employed in farming, and the county population all in 1930.

Table 11: Drought severity and crop failure in 1934

	(1) Percent of acres failed
Drought severity in 1934	0.021***
	(0.006)
Observations	3,017

Standard errors clustered by 1930 state in parentheses

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

Notes: This table estimates the county-level relationship between drought severity in 1934 and crop failures. Increasing drought severity by an index value of one (moving from a moderate to severe drought for example) was associated with an increase in crop failures by 2.1 percentage points. Crop failures were assessed at the acre level. For an acre to have *failed* it must have produced no crop. Therefore, overall declines in output were much higher than the percent crop failure suggests on the surface. This finding is similar to the relationship documented in Figure 4, but here county-level covariates and state fixed effects are controlled for.

and 3). This outcome is expected as we tend to think of droughts primarily impacting agricultural production and the agricultural sector. Table 11 shows that drought severity in 1934 was positively correlated with the percent of crop acres failed in 1934. This result is similar to the relationship displayed in Figure 4 (of Chapter 3) but the results in Table 11 control for county-level characteristics and state fixed effects. That is, the results in Table 11 move us towards a causal interpretation of the impact of drought on agricultural production. The result that drought had a significant impact on agricultural production is expected and consistent with a large body of research on the impact of drought, heat, and lack of rain on agricultural output.[48]

Nevertheless, the results of this Table 10 column 3 provide evidence that drought also impacted the urban sector. Beyond impacting the agricultural supply chain, which may impact the urban sector, drought (or the heat associated with drought) potentially impacted the economy outside of the agricultural sector through heat related morbidity and mortality. The heat impacts of drought may have been more pronounced in cities through an effect known as the urban heat island in which cities are hotter on average than the surrounding countryside (Wouters et al. 2017).

[48] See Adams et al. (1990), Mendelsohn and Sanghi (2001), Schlenker and Roberts (2006), Deschenes and Greenstone (2007), Libecap and Steckel (2011), Bleakley and Hong (2017), and Feng et al. (2017).

The excess heat of cities, perhaps combined with a higher fraction of the population working in buildings, might have led to heat related morbidity and mortality. The idea that drought impacted the economy through channels not directly related to agriculture is consistent with a number of recent papers document the impact of heat on industrial production and human health, especially in communities without widespread adoption of air conditioning.[49]

Discussion

This Chapter estimates the relationship between drought and migration at the county-level. I find that drought was strongly correlated with migration starting in 1934 and continuing through the second half of the decade. The depopulation associated with drought was a function of both increased out-migration and decreased in-migration, not simply a function of increased out-migration. These findings expand our understanding of the details and geographic expanse of migration related to environmental conditions. Additionally, these findings add specificity to the timing of changes in migration patterns from a persistent shock. Therefore, this Chapter contributes to our knowledge of how environmental shocks influence migration and population distributions.

The results of this chapter are novel in the context of the widespread drought but are largely consistent with previous research related environmental degradation during the 1930s. First, the result that the depopulation was function of both increased out-migration and decreased in-migration is consistent with literature on the core of the Dust Bowl (Long and Siu 2018). These findings are important to the broader climate migration literature because they show that environmental shocks impact both the push and pull factors of migration. In the late 1930s, half of

[49] Deshchenes and Moretti (2009), Hsiang (2010), Dell et al. (2012), and Barreca et al. (2016).

the depopulation related to drought was the result of people not moving into the counties to replace migrants who had left.

The result that drought exposure was correlated with depopulation in the late 1930s is consistent with literature on the core of the Dust Bowl (Riney-Kerhberg 1994), with literature on the Great Plains as a whole in the context of soil erosion (Hornbeck 2020), and with literature on migration from heat across the western U.S. (Gutmann et al. 2016). In comparison to the late 1930s, the early 1930s have received considerably less research attention because of the need to link between censuses to study migration from 1930 to 1935. While the possibility of false census linkages confounds some migration results, there was a strong migration response to drought severity in 1934. This result indicates that 1934 was the turning point for drought. Prior to 1934, the drought was severe and prolonged in some areas but not unprecedented as a whole. The year that the 1930s became an important period of climate migration was 1934.

The finding that 1934 was definitive in terms of migration from drought is a new but not unprecedented. The lagged timing of migration from the Dust Bowl in particular is discussed by Riney-Kerhberg (1989). Further bolstering the argument for the importance of 1934, state-level tabulations of migrants from popular destination states show a sharp increase starting in the mid-1930s (Taylor and Vaset 1936, Hoffman 1938). One observer in Oregon wrote: "Very little attention was given to the movement until the summer of 1934. At that time, various groups interested in the situation became alarmed at the constantly growing stream of drought refugees" (Hoffman 1938).

Finally, this Chapter also described how drought impacted Depression severity at the county-level and discusses channels through which drought impacted the economy. Additional drought years had large impacts on retail spending. Drought clearly impacted economy through agricultural production. But likely, the drought also impacted retail spending by impacting human health and industrial production. This chapter provides a brief entry into the relationship between drought and the Great Depression. Considering the magnitude and strength of the relationship between drought and Depression severity documented in this chapter, drought's impact on the depth and length of the Great Depression is an area that warrants much more research.

In all, this chapter provide a relatively high-level perspective on the relationship between drought and migration. This analysis provides a basis for the following chapters, which go into more detail about the specifics of migration and the consequences for migrants. Chapters 6 and 7 utilize individual-level data to detail the demographics of drought migrants, explain where they went, and estimate how they fared at their destinations.

CHAPTER 6

ECONOMIC RESPONSES TO DROUGHT 2: MIGRANT SELECTION AND SORTING FROM 1935 TO 1940

Migration is expensive and risky. Not everyone can afford to move and not all moves are equal in terms of expected returns. Both the socio-economic characteristics of migrants and their destinations are important to understanding the economic consequences of migration for individual migrants and the broader economy. To that end, this chapter studies how the drought impacted both the decision to move and where to go heterogeneously by individual-level human capital.

Migrants are usually not randomly selected from their origin population. *Positive selection into migration* is well documented in situations not involving environmental shocks.[50] But the influence of environmental shocks on selection into migration is not well understood. On one hand, people with higher income or education may be more able to move in response to environmental shocks because they can more easily cover the cost of migration. On the other hand, people with higher income often have more savings and thereby are able to mitigate temporary wage loses. Therefore, the need to move from environmental shocks might not be as immediate. Additionally, environmental shocks disproportionately impact certain sectors of the economy, which also influences selection into migration. Taken together, environmental shocks could theoretically induce either positive or negative selection.

[50] *Positive selection into migration* means that migrants have higher wages, education, human capital, or some observable characteristic compared to non-migrants at their origin location. See Ó Gráda and O'Rourke (1997), Abramitzky et al. (2012), Collins and Wanamaker (2014), and Spitzer and Zimran (2018).

Studying selection, or the composition of migrants leaving an impacted area is important to understanding the overall impact of shocks because migrants may mitigate the effects of shocks by moving away. This action is good for the migrants themselves, but if the shock disproportionately induces migration among individuals with high human capital (as was the case from the 1930s drought), those left behind suffer not only the climate shock but the secondary shock of the withdrawal of the best educated and wealthiest community members.[51] Given the ambiguity of the impact of environmental shocks on selection, and the importance of selection for understanding the implications of shocks, this chapter studies how the drought heterogeneously impacted migration decisions by individual education.

At the end of each migration, there is a destination. Destinations may also vary based on individual characteristics, and destination choice is important for the future prosperity of the migrants themselves and the economy as a whole. In the context of large movements of people, destination choice has large consequences for popular destinations. The sudden influx of migrants can lower wages for natives and increase unemployment among both migrant and native workers (Boustan et al. 2010). Furthermore, overcrowding of cities may lead to increases in disease and mortality (Haines 2001). Finally, if a climate shock is geographically widespread, migrants may be pushed into different regions or countries creating regional and international tension (Barnett and Adger 2007). This scenario certainly occurred during the 1930s when California tried to limit the number of migrants entering the state, and prejudice against internal migrants was common (Worster 2004). Because of the importance of destination choice, this chapter also studies where migrants went heterogeneously by human capital.

[51] In extreme circumstances, like the 19th century Irish Famine, individuals able to migrate survived while those who stayed disproportionately died (Ó Gráda and O'Rourke 1997).

To document who migrated and study the characteristics of destinations, I match 1940 U.S. census data with county-level drought data as described in Chapter 3. The 1940 census includes demographics and individuals' locations in 1935 and 1940 (Ruggles et al. 2019). The inclusion of 1935 location enables the study of migration between 1935 and 1940 without linking between censuses. Studying migration without census linking has two major advantages. First, I study the entire adult population rather than the subset that was successfully linked between censuses (subject to selection into linkage and false linkages). Second, and closely related, using the full count census enables the study of migration for both women and men whereas most historical migration studies focus on men because linking women is difficult given name changes at marriage.

I find that the migration response to additional drought years was concentrated among relatively well-educated individuals. Individuals with a high school education or higher (roughly the top one-fourth of the education distribution) were 5.9 percentage points more likely to leave counties with three or more years of drought compared to observationally similar individuals from non-drought counties (counties that had zero or one year of drought in the late 1930s). This increased migration for highly educated individuals occurred among both women and men and from both city and non-city locations. But drought induced a smaller migration response among individuals with an 8th to an 11th grade education and no migration response for individuals with less than an 8th grade education after controlling for individual, county, and state observables. That is, highly educated people moved away from the drought at higher rates, whereas people with less education more often persisted in drought counties.

This result is consistent with findings from modern development economics literature but expands on previous research by documenting the individual-level migration responses. Previous research shows that migration away from climate and weather shocks largely occurs in middle and high-income areas (Cattaneo and Peri 2016, Bazzi 2017). This finding is typically explained by recognizing migration as costly and reasoning that individuals with low wealth more often lack the required liquidity to pay for the upfront cost of migration (Chiquar and Hanson 2005, Angelucci 2015, Bazzi 2017). Yet, previous research focuses on migration responses based on the *average* wealth of localities, whereas I study the migration response based on individual-level human capital. That is, previous research shows that people in higher income areas are more responsive to climate shocks. I show that people with high human capital are *individually* more responsive to climate shocks. My finding is important because previous results introduce the question of whether the responsiveness in higher-income areas is driven by local amenities or responsiveness among affluent individuals in particular. My research clarifies this ambiguity by showing that affluent people specifically moved away from drought whereas less affluent people did not.

Drought induced positive selection into migration during the 1930s because individuals with higher human capital were more able to cover the upfront cost of migration. For residents of Dust Bowl counties, when asked "If you remained in southwestern Kansas from 1930 to 1940, why did you stay?" The most common response was that they did not have the money to leave or anywhere to go (Riney-Kehrberg 1994). As further evidence that liquidity bound people to drought locations, I document that more severe economic downturns during the Great Depression (which made credit and liquidity harder to come by) further induced positive selection into migration from drought counties. The result that individuals with little education were constrained by liquidity highlights that this subset of the population was, and likely remains, particularly vulnerable to decreased standards of living and increased morbidity resulting from climate shocks.

This chapter also details where migrants went with an emphasis on city or non-city destinations. Over the past millennia, the dominant migration was from rural to urban centers, but that trend can hide differences in migration at particular points in time.[52] Moreover, a number of papers stress the importance of urbanization resulting from climate shocks (Cohen 2016, Cattaneo and Peri 2016, Peri and Sasahara 2019). I find that migrants primarily moved to non-city destinations (where cities are defined as urban areas with more than 20 thousand residents in 1940).[53] The preference for non-city destinations was strongest among people from non-city origins—75 percent of such migrants relocating to non-city destinations. But there was also substantial movement out of cities, with 47 percent of migrants who originated in a city relocating to non-city destinations. Moreover, migrants from drought counties were even more likely to relocate to non-city destinations compared to observationally similar migrants from non-drought counties and controlling for the distance to the nearest city.

These findings contribute to Depression-era and current climate migration literatures on selection into migration and sorting of migrants. The drought of the late 1930s impacted over 10 million people across much of the western United States but it was only the highly educated who migrated away from local drought severity in higher numbers. In this way, the drought of the 1930s is a story of inequal opportunity. Individuals with less human capital disproportionately persisted in drought counties and dealt with the negative impact of the drought while more educated individual were able to move and potentially dissipated some of the negative impact of drought.

[52] Often the migration from rural to urban economies is explained in terms of urban wage premiums (Hatton and Williamson 1992, Gould 2007).

[53] Locations are defined as *cities* by the Integrated Public Use Microdata Series (IPUMS) and are different from the IPUMS definition of *urban* which include smaller urban areas for 2,500 residents or more.

Conceptual background: selection into migration from climate shocks

In a theoretical sense, economic reasoning suggests that people should move if the expected benefits of residing in another location exceed the benefits of staying in their current location net of the cost of moving and conditional on having enough money to pay for the cost of migration (Sjaastad 1962, Borjas 1987, Chiquiar and Hanson 2005, Armstrong and Lewis 2012). Because the costs and benefits of migration vary by individual characteristics, migrants are rarely randomly selected from their origin population. Human capital, or skill, is a key variable in the decision to migrate because skill relates to variables that enable migration, such as income, wealth, and liquidity, and to the expected returns of migration.

When a climate shock impacts particular areas, it creates new incentives to relocate. Most directly, climate shocks increase the push factors for migration by negatively affecting the living conditions of the impacted area. Not surprisingly, a number of studies find that weather and climate shocks induce migration out of the affected area.[54] Yet some studies find little, no, and even negative effects of climate and weather shocks on out-migration for large segments of populations, attributable to binding liquidity constraints.[55] Poor individuals may want to move, but may not have the liquidity to pay the cost of migration (Bryan 2014, Angelucci 2015, Bazzi 2017, Spitzer et al. 2020).

Models of migrant selection provide the framework to anticipate the impact of drought on selection into migration. McKenzie and Rapoport (2010) build on Roy (1951) and Borjas (1987) to show that large migrant networks lower the cost of migration by providing information, housing services, and relaxing credit constraints. Therefore, large networks tend to reduce the amount of

[54] See Reuveny and Moore (2009), Boustan et al. (2012), Hornbeck (2012), Bohra-Mishra et al. (2014), Hornbeck and Naidu (2014), and Kleemans and Magruder (2018).
[55] See Kleemans (2015), Cattaneo and Peri (2016), Nawrotzki and DeWaard (2018), and Beine et al. (2019).

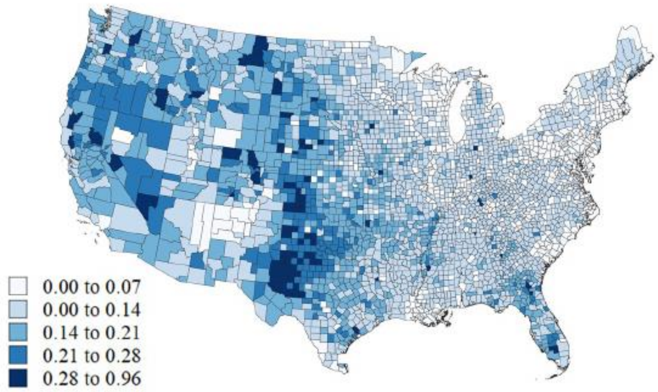
positive selection into migration. This result has two implications for studying selection into migration from drought during the Great Depression. First, drought and Depression severity are expected to work in the opposite direction as large migrant networks. Drought should constrain credit and liquidity and thereby induce more positive selection into migration. Additionally, if drought is increasing positive selection into migration through liquidity constraints, positive selection should increase even more in drought areas that were more adversely impacted by the Great Depression. This prediction is tested in the results section.

Summary statistics on drought exposure and migration by education level

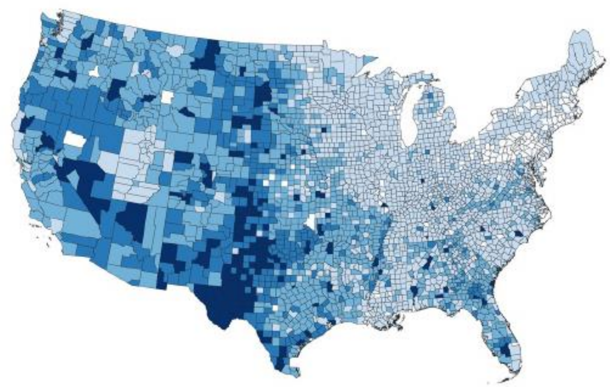
This section describes how migration varied by drought and education to provide context on how these variables were related. Figure 14 disaggregates county-level out-migration by education attainment category. There are two main points to take from Figure 14. First, is that as education increases, the figures become darker in shade. This indicates that as education increased so did the likelihood that an individual would migrate. That is, there was positive selection into migration that was not necessarily related to drought conditions (highly educated people moved more overall). Second, while the frequency of out-migration varied by education, the geographic distribution of out-migration looked similar regardless of education level. People of all education levels were leaving roughly the same counties but at different rates.

To evaluate destinations of migrants based on education level, Figure 15 displays county level in-migration. Again, the two main takeaways from Figure 14 are also true in terms of in-migration in Figure 15. There was more migration among highly educated individuals, and highly educated and less educated people were going to roughly the same destinations.

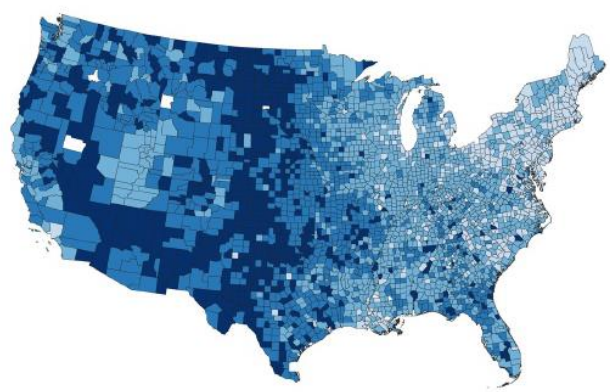
Figure 14: Fraction of 1935 population to have left by 1940 by education category



(a) < 8th grade education



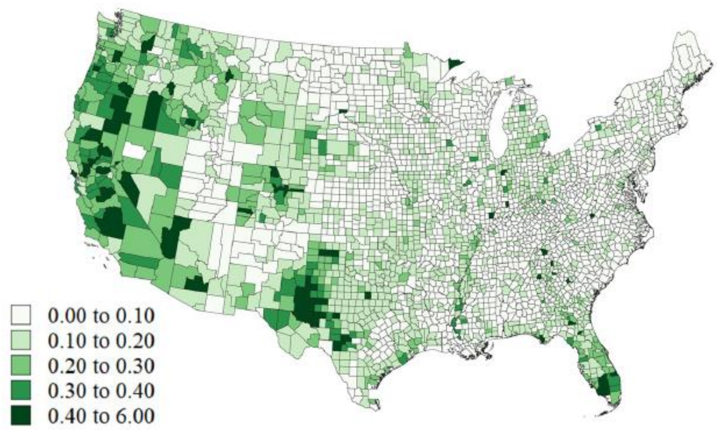
(b) 8th to 11th grade education



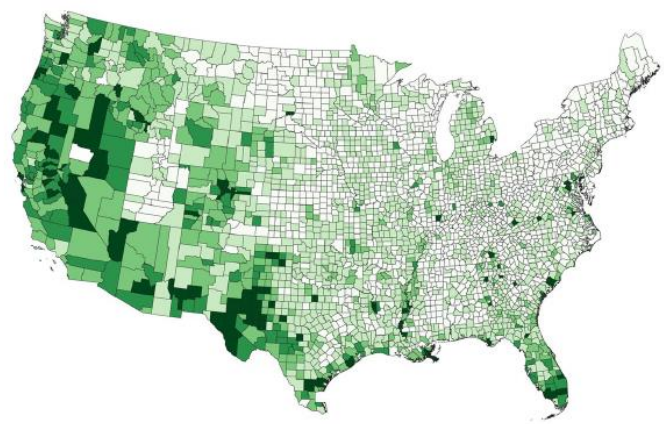
(c) > 11th grade education

Notes: This figure shows out-migration distinguishing by education level. Out-migration looks similar but has different intensities across education levels: migration became more common (the figures become darker) as education increased. This indicates that there was positive selection into migration in terms of education not necessarily related to drought conditions. Sample includes adults in full count 1940 census (25 to 65 in 1935). Data sources: Ruggles et al. (2019) and Manson et al. (2019).

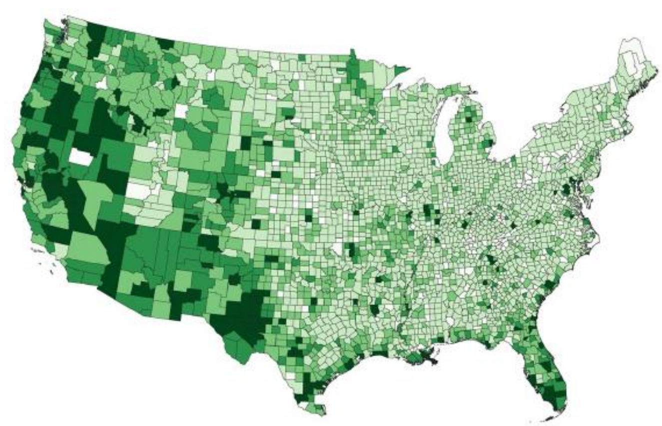
Figure 15: New residents entered by 1940 as a fraction of 1935 population by education category



(a) < 8th grade education



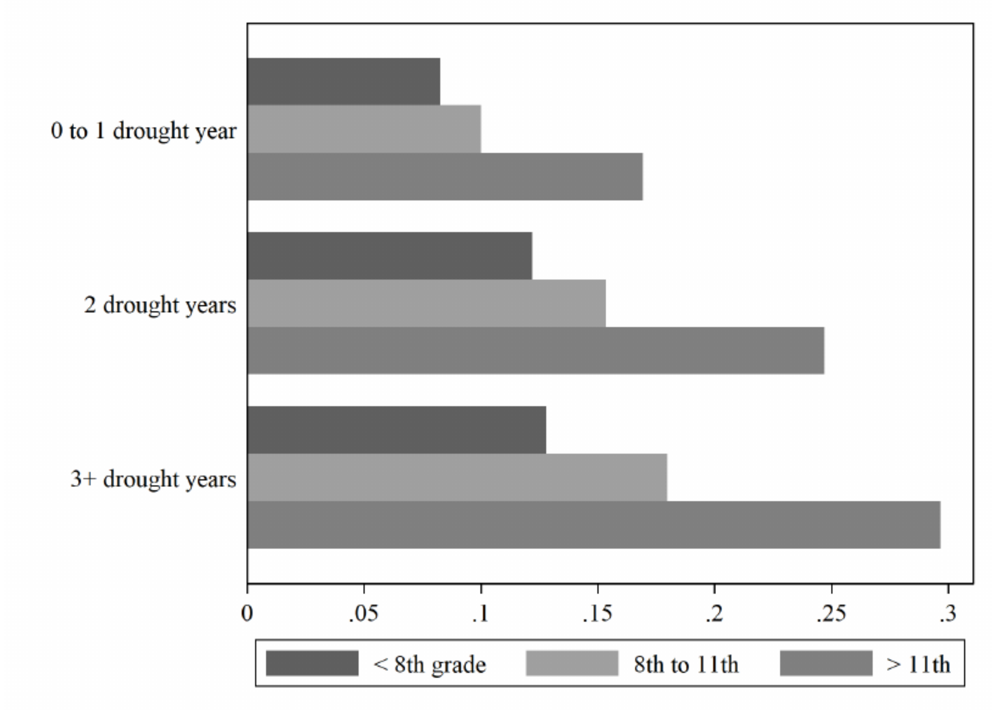
(b) 8th to 11th grade education



(c) > 11th grade education

Notes: This figure shows in-migration distinguishing by education level. In-migration looks similar across education levels. Most migrants were moving into counties in the western United States. Furthermore, as seen in the out-migration by education figure, migration became more common as education increased. Sample includes adults in full count 1940 census (25 to 65 in 1935). Data sources: Ruggles et al. (2019) and Manson et al. (2019).

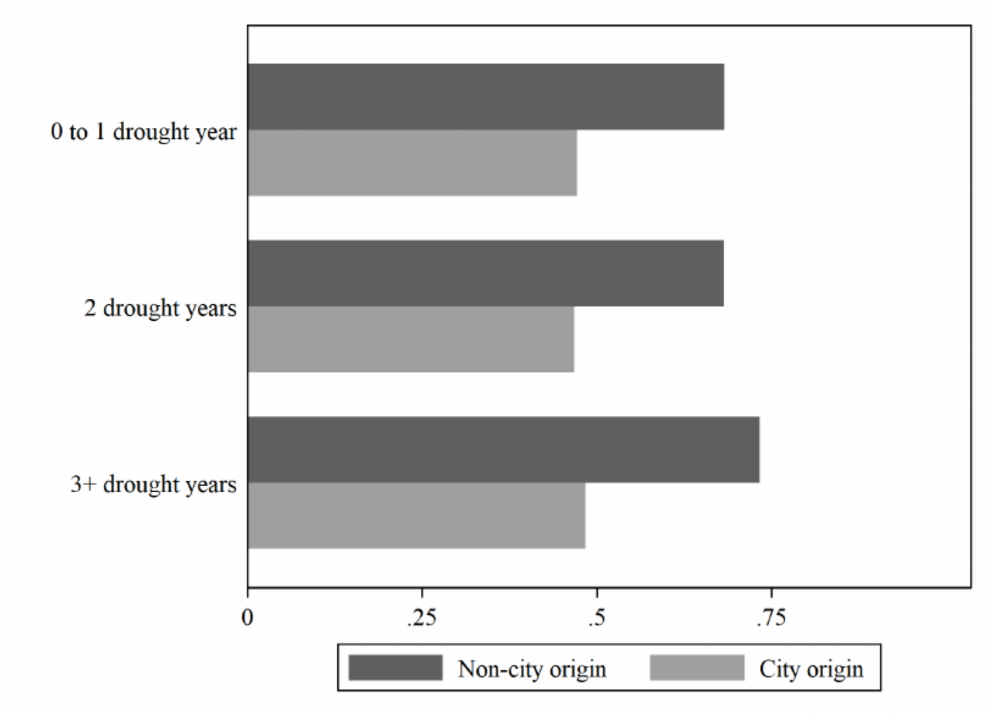
Figure 16: Fraction of individuals to have migrated by education and drought



Notes: This figure displays the fraction of individuals by education and drought years to have moved between 1935 and 1940. Starting from the top of this figure, we see that roughly eight percent of individuals with less than an 8th grade education and in counties with zero or one year of drought moved. The fraction of individuals who moved increased both with education and drought exposure. Data sources: Cook et al (2010), Ruggles et al. (2019) and Manson et al. (2019).

To descriptively characterize selection into migration related to drought, Figure 16 displays the fraction of individuals who migrated differentiating between drought years at their origin county and individual education attainment. Again, we see that migration became more common as educational attainment increased for both non-drought and drought counties. Moreover, we see that migration increased for all educational attainment categories as drought years increased but that the increase in migration rates was most pronounced among individuals with a 12th grade education or higher. Figure 16 highlights an important point when interpreting the results of this chapter: people with less education were leaving drought counties at higher rates than other counties. But this relationship does not hold econometrically, when I control for observables and

Figure 17: Fraction of migrants who moved to non-city locations



Notes: This figure shows the fraction of migrants by drought years and origin location (non-city or city) who relocated to non-city destinations. Nearly regardless of drought years at their origin county, roughly 75 percent of migrants who started in non-city locations moved to other non-city locations. Additionally, nearly 50 percent of migrants who started in city locations relocated to non-city locations. This figure shows that the majority of migration was to non-city destinations. Data sources: Cook et al (2010), Ruggles et al. (2019) and Manson et al. (2019).

state fixed effects. That is, people with little formal education in drought counties had higher migration rates than similarly educated people in non-drought counties. However, I am not able to show that these higher migration rates were attributable to local variation in drought intensity.

Finally, to study how drought impacted distinct portions of the economy, this chapter differentiates between people who started in city versus non-city locations and whether migrants relocated to city or non-city destinations. Figure 17 displays the fraction of migrants, distinguishing by origin type to have relocated to city and non-city destinations. The majority of migrants, regardless of drought exposure, made non-city to non-city moves. Nearly 75 percent of migrants who started in non-city locations moved to other non-city locations almost regardless of drought. In terms of descriptive statistics, there was not a substantially higher propensity for individuals from drought counties to move to cities. Furthermore, of migrants who started in city locations, nearly half relocated to non-city destinations. While the rural-to-urban transition is often conceptualized as a monotonic process whereby economies become increasingly urbanized overtime, the 1930s show that there can be substantial movement out of cities as well, and that it is not obvious that people moving away from environmental shocks necessarily favor city destinations.

Empirical framework

The empirical analysis estimates the probability of migration for individuals in counties with more years of drought relative to the probability of migration for observationally similar individuals in counties with fewer years of drought within the same state. Equation 3 is written in vector notation for compactness here but written out fully in the following footnote.[56]

$$(3)\ M_i = \alpha + \beta_1 E_i + \beta_2 D_c + \beta_3 (D_c \times E_i) + \theta_1 X_{i1935} + \theta_2 X_{c1935} + \gamma_{s1935} + \gamma_a + \varepsilon_i$$

The outcome 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 the interactions between drought years and education attainment ($D_c \times E_i$), state fixed effects (γ_{s1935}),

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

age fixed effects γ_a, a vector 1935 individual characteristics (X_{i1935}), a vector 1935 county characteristics (X_{c1935}), and an error term (ε_i).

The vector of indicator variables for 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 from 1935 to 1940. The omitted category are counties that experienced zero or one drought year.[57] The vector of indicator variables for educational attainment (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 are individuals with less than an 8th grade education. The vector of indicator variables for drought years is interacted with the vector of variables for education attainment ($D_c \times E_i$). The omitted category is individuals with less than an 8th grade education and from a county with zero or one year of drought. The vector of 1935 individual controls (X_{i1935}) includes: number of children, an indicator variable for whether the person was male, white, foreign born, in a city, and in their birth state. The vector of 1935 county controls (X_{c1935}) includes: average age, fraction male, fraction white, fraction in a city, fraction in birth state, average education in years, fraction foreign born, population, number of moderate or worse drought years from 1930 to 1934, wind erosion severity in 1930s, and log change in per capita retail sales from 1929 to 1933.

The coefficients on the vector of education indicators (β_1) estimate whether individuals with higher levels of education were more likely to migrate for the omitted drought group (counties with zero or one year of drought). Positive β_1 values indicate that there was intermediate selection

[57] 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. Moreover, one moderate or worse drought year is typically for a county over a five-year time interval given normal climatic fluctuations. All results are robust to separating zero and one year of drought into two different categories. There was little differential migration out of counties with one year of drought across education levels. Separating zero and one year of drought into two different categories has minimal impact on the coefficients for migration from counties with two or more years of drought and the interaction terms.

(in the case when the coefficient for 8th to 11th grade education: β_{11} is positive) and positive selection (in the case when the coefficient for 12th grade education or higher: β_{12} is positive) into migration for individuals from non-drought counties. The coefficients on the vector of drought indicators (β_2) estimate how drought years impacted migration decisions for the omitted education group (individuals with less than an 8th grade education). Positive β_2 values indicate that the migration propensity for individuals with less than an 8th grade education increased with exposure to drought. The coefficients on the interaction term (β_3) of drought years and education attainment estimate the difference in migration propensity between individuals with higher levels of education in drought counties relative to the omitted category (individuals with less than an 8th grade education in non-drought counties). Positive β_3 values indicate that the gap in migration propensity between more highly educated people and less educated people was larger in drought counties compared to non-drought counties and therefore indicates that drought induced positive selection into migration.

There are a number of ways in which drought could induce more positive selection into migration as measured by β_3. For example, drought could lower the migration propensity of individuals with less than an 8th grade education but not impact the migration propensity of individuals with higher education (β_2 < 0 and β_3 > 0). Alternatively, drought could have a neutral impact on migration for individuals with less than an 8th grade education but increase the migration propensity of more highly educated individuals (β_2 = 0 and β_3 > 0). In both cases, the estimated β_3 value might be the same, but how drought is impacting migration is different.

Therefore, it is crucial to consider β_3 in the context of β_2, or the summation of the relevant coefficient in each vector. This step tells us whether drought induced more or less migration for a particular education category. For instance, the impact of three or more drought years on the migration propensity of individuals with a 12th grade education or higher is equal to the sum of the coefficient on the indicator variable for three or more drought years (β_{22} in the β_2 vector) and the coefficient for three or more drought years interacted with the indicator for a 12th grade education of higher (β_{34} in the $\beta_3$vector). As such, I supplement all regression output tables in this chapter with coefficient plots that display how migration propensities for each education category differed by drought years at the origin county relative to the same education category in non-drought counties.

Selection results

The out-migration response to additional drought years in the late 1930s was concentrated among individuals with relatively high education as shown in column 1 of Table 12. High school educated individuals in counties that subsequently experienced two years of drought were an additional 3.4 percentage points more likely to have moved compared to individuals with less than an 8th grade education.[58] The magnitude of the coefficient increases to 6.4 percentage points for high school educated individuals from counties with three or more years of drought, as seen in the last row of column 1. The additional propensity to migrate from drought was also true for individuals with an 8th to 11th grade education but to a lesser extent. By contrast, additional drought years had a neutral effect on the migration propensities of individuals with less than an 8th grade education as these estimates are close to zero and insignificant as seen in the third and fourth rows of column 1.

[58] This additional propensity is in relation to the underlying migration propensity gap of 6 percentage points between individuals with a 12th grade education or higher versus individuals with less than an 8th grade education as seen in the second row.

Table 12: Migration response to number of drought years by education attainment

	(1) Migrant	(2) Migrant	(3) Migrant	(4) Migrant	(5) Migrant	(6) Migrant
8th to 11th grade ed.	0.011***	0.012***	0.010***	0.038***	0.006*	0.008***
	(0.002)	(0.002)	(0.002)	(0.005)	(0.003)	(0.002)
> 11th grade ed.	0.060***	0.057***	0.064***	0.122***	0.027***	0.057***
	(0.003)	(0.003)	(0.004)	(0.006)	(0.005)	(0.006)
2 drought years	0.000	-0.002	0.002	0.018	-0.004	0.012
	(0.007)	(0.007)	(0.008)	(0.019)	(0.010)	(0.021)
3+ drought years	-0.005	-0.008	-0.003	-0.016	0.022	0.017
	(0.006)	(0.006)	(0.006)	(0.021)	(0.016)	(0.010)
(2 drought years)×(8th to 11th)	0.009	0.011*	0.008	0.013	0.004	0.007
	(0.006)	(0.006)	(0.006)	(0.010)	(0.006)	(0.008)
(3+ drought years)×(8th to 11th)	0.018***	0.022***	0.015***	0.043***	0.012**	0.016**
	(0.004)	(0.004)	(0.005)	(0.014)	(0.005)	(0.006)
(2 drought years)×(> 11th)	0.034***	0.036***	0.033***	0.045***	0.012	0.022*
	(0.009)	(0.008)	(0.011)	(0.015)	(0.011)	(0.012)
(3+ drought years)×(> 11th)	0.064***	0.066***	0.062***	0.085***	0.043***	0.050***
	(0.008)	(0.007)	(0.009)	(0.013)	(0.010)	(0.009)
Observations	55,326,741	27,387,808	27,938,933	7,823,756	7,187,616	25,585,743
Sample	Adults	Women	Men	Non-city non-farm origins	Farm origins	City origins

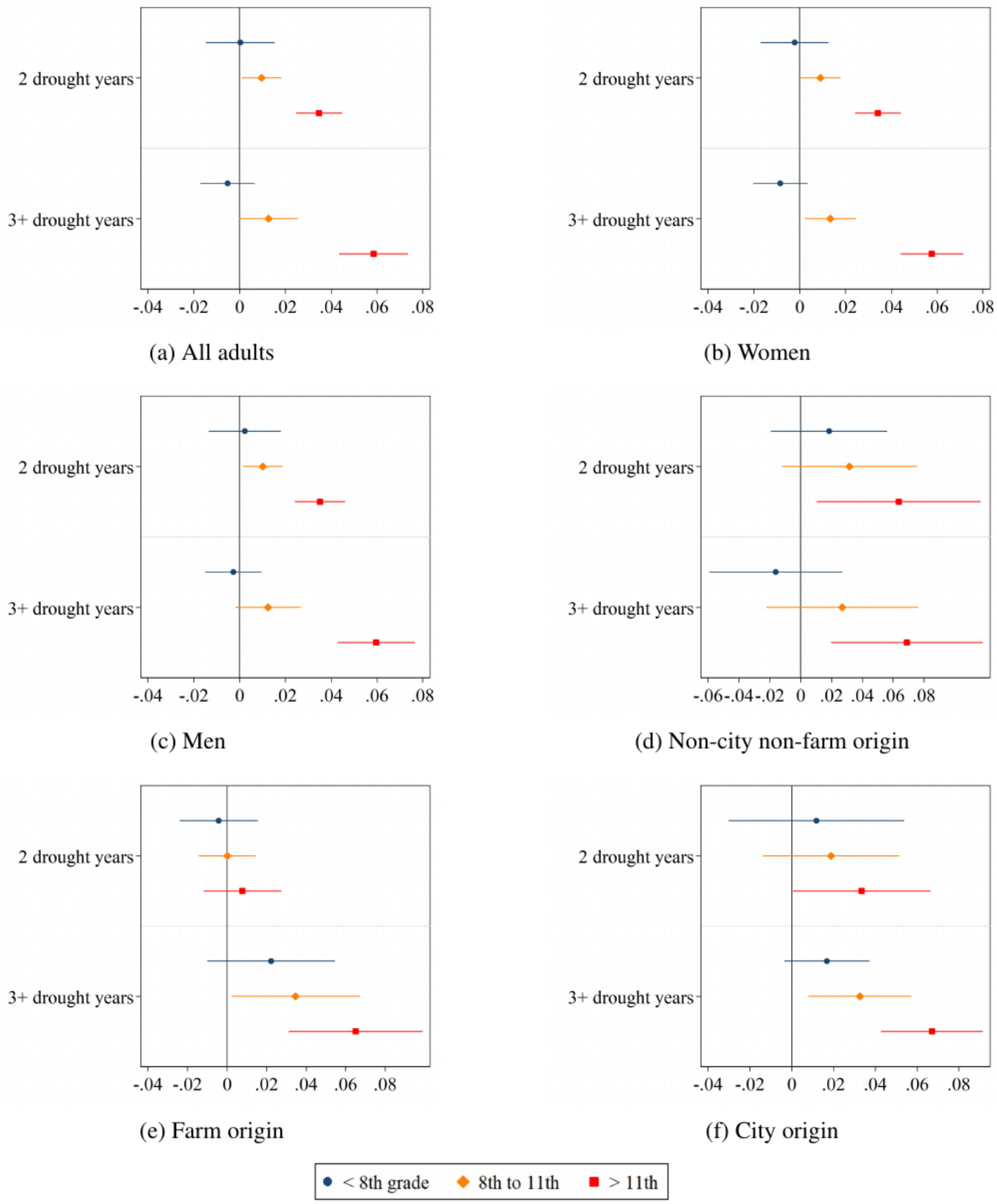
Standard errors clustered by 1935 state in parentheses

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

Notes: These results estimate whether drought impacted migration deferentially based on education level. These are the results from estimating Equation 3 and are presented in graphical form by Figure 18. As an example of how to interpret the magnitudes of these coefficients, the first coefficient in column 1 estimates that individuals (from non-drought counties) with an 8th to 11th grade education were 1.1 percentage point more likely to migrate than individuals with less than an 8th grade education. The third and fourth rows of column 1 show that drought had little impact on the migration propensity for individuals with less than an 8th grade education. At the same time, drought increased intermediate and positive selection into migration as seen in the last three rows. These results largely hold for both women and men (columns 2 and 3) and from non-city non-farm, farm, and city origins (columns 4, 5, and 6). Sample includes adults (25 to 65 in 1935). Regressions include age and state fixed effects, and individual and county controls as discussed in the context of Equation 3.

Higher migration rates among highly educated individuals from drought counties in the context of a neutral migration response among individuals with less than an 8th grade education implies that highly educated individuals from drought counties were moving more than similarly educated individuals in non-drought counties. To illustrate this point, Figure 18 plots the sum of the coefficients for the impact of drought years for the omitted category (an individual with less

Figure 18: Migration response to number of drought years by education attainment



Notes: These results correspond to Table 12. The coefficients displayed in these figures are the estimated impact of drought years on migration propensity for individuals of different education levels relative to observably similar individuals (in the same education category). As an example of how to interpret the magnitudes of these coefficients, the last coefficient in (a) estimates that individuals with greater than an 11th grade education and from a county with three or more years of drought were 5.9 percentage point more likely to migrate than individuals of the same education level from non-drought counties.The primary impact of drought was to increase migration for individuals with a 12th grade education or higher. Drought had a more minor impact on the migration propensity for individuals with an 8th to 11th grade education. This result holds for women and men, and for individuals from non-city non-farm, farm, and city origin locations. Sample includes adults (25 to 65 in 1935). Regressions include age and state fixed effects, and individual and county controls as discussed in the context of Equation 3.

than an 8th grade education) and the relevant interaction term between drought years and education category.[59] These coefficients display the change in migration propensity of individuals relative to an individual in the *same* education category from a non-drought county. For example, individuals with a high school education and from a county that experienced three or more drought years were 5.9 percentage points more likely to move compared high school educated individuals from non-drought counties. At the same time, individuals with less than an 8th grade education in drought counties moved at roughly the same rates as individual with similar education in non-drought counties.

Given the detail of individual-level data, I disaggregate these results along a number of dimensions. Of particular interest is whether men and women responded differently and whether people responded differently based on characteristics of their origin location. The pattern of higher intermediate and positive selection from drought holds for both women and men (Table 12 columns 3 and 4 and Figure 18.b. and 18.c.). Women and men migrated away from drought at similar rates. The majority of people in this age range (70 percent) were married by 1940. Among married individuals the migration response to drought was virtually identical between women and men, suggesting that couple or families were moving together in response to drought. Couples and families migrating as a unit is indicative of permanent moves, and is an interesting finding in light of research showing that migrations from some negative weather shocks are largely composed of temporary moves executed by one household member to send remittances back to the family (Kleemans 2015). Likely, the length and severity of the climate shock plays a role in whether moves are temporary or permanent. In the late 1930s, some people were dealing with drought that had persisted since the early 1930s.

[59] This is the sum of the coefficient in the fourth row (3+ Drought Years) and the last row (3+ Drought Years)×(> 11th) of Table 12.

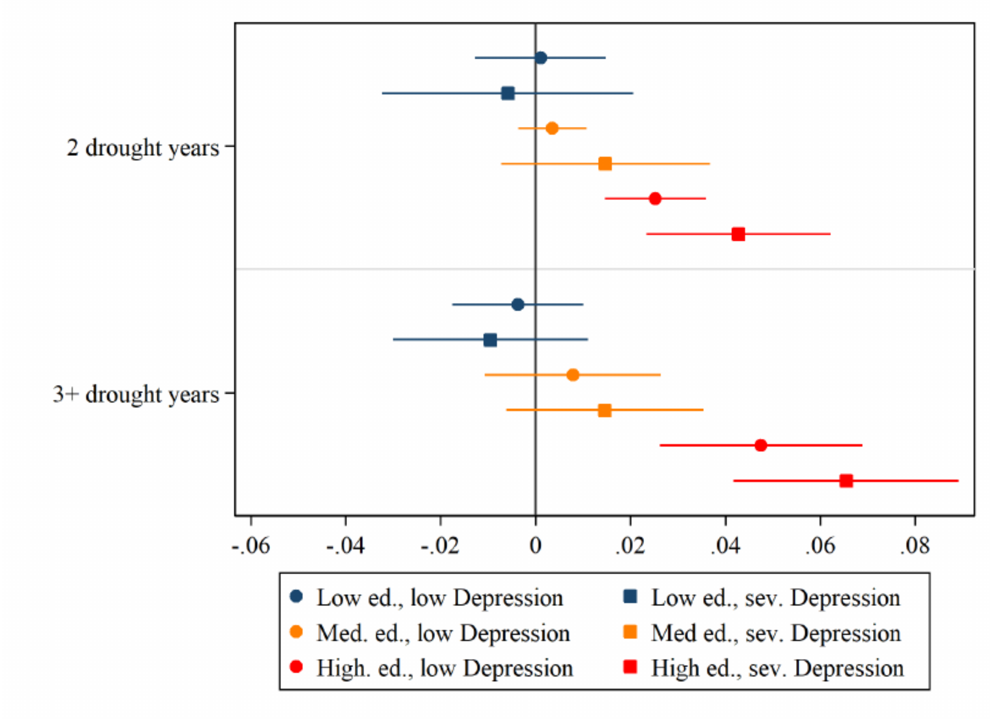
The pattern of higher intermediate and positive selection from drought holds when disaggregating the sample between non-city non-farm, farm, and city origins (Table 12 columns 5, 6, and 7, and Figure 18.d., 18.e., and 18.f.). The result that people moved away from cities in drought is novel because research on the migration impact of climate shocks focuses on the impact on the rural sector. Additionally, cities are often considered destinations for climate migrants. Nonetheless, given previous research showing that climate shocks have widespread impacts outside of the agricultural sector (Hsiang 2010, Dell et al. 2012, Barreca et al. 2016), it is not surprising that people migrated away from drought conditions from both non-city and city origins.

Selection mechanism

So why, when faced with severe and persistent drought, did individuals with less human capital not move more frequently? A number of papers posit that individuals with low human capital or wealth are more often constrained in their migration decisions because they do not have the required liquidity to pay the up-front cost of migration (McKenzie and Rapoport 2010, Bazzi 2017). This section briefly explores this explanation in the context of the 1930s drought.

The liquidity constraint explanation is consistent with historical research focused on the Dust Bowl. Riney-Kehrberg (1994) conducted a survey of people who stayed in Dust Bowl counties. The most common response to the question of why you stayed was that they did not have the money to leave or anywhere to go. Although, this survey was of people in the Dust Bowl in particular, it seems likely that a similar sentiment extended through the broader drought. The 1930s were the decade of the Great Depression, the Depression was long lasting in drought counties, and much of the drought region struggled in the 1920s as well. These conditions likely contributed to difficulties in paying for the cost of migration.

Figure 19: Selection into migration by Depression severity at origin counties



Notes: These are the results from estimating Equation 3, distinguishing by Depression severity at origin counties. Depression severity may have further constrained individual liquidity. The results that there was more positive selection from counties with worse Depression severity is consistent with the hypothesis that liquidity played a role in the increased positive selection into migration resulting from drought conditions.

To further examine the role of liquidity and Depression severity, I estimate whether the degree of selection into migration from drought varied based on the severity of the Great Depression at origin counties. If it was the case that people with lower human capital wanted to move from drought conditions but lacked the required liquidity to pay for the cost of migration, then we expect even more selection from counties that suffered more severe economic downturns.

Figure 19, displays the results from splitting the sample between origin counties with lower and higher than average economic downturns from 1929 to 1935.[60] The coefficients of all of the interaction terms are larger from counties with more severe economic downturns, indicating that

[60] I define counties with *low* and *high* Depression severity based on being above or below the mean county-level Depression severity (*change in retail sale per capita from 1929 to 1935*).

intermediate and positive selection from drought was more pronounced in counties where liquidity constraints were more likely to be binding. This result is consistent with the hypothesis that individuals with lower human capital more often lacked the liquidity required to move away from drought.[61]

Sorting results

Migration is a decision of whether to leave and where to go, and destination characteristics varied based on each individual's circumstances. This section analyzes how migrant destinations changed with drought exposure and education attainment. Because city or non-city status is a defining characteristic in terms of employment opportunities and way of life, I focus on how destination differed in terms city or non-city status.

Equation 4 is a modification of Equation 3 that is designed to compare how destinations differed based on drought at the migrant's origin county and their education.

$$(4)\ R_{i1940} = \beta_1 E_i + \beta_2 D_c + \beta_3 (D_c \times E_i) + \theta_1 X_{i1935} + \theta_2 X_{c1935} + \gamma_{s1935} + \gamma_a + \varepsilon_i$$

Equation 4 has the same independent variables as Equation 3, but the outcome variable *migrant* in Equation 3 is replaced with an indicator variable equal to one if a migrant's destination was a non-city location. Furthermore, the sample for Equation 4 is restricted to migrants. Crucially, Equation 4 includes state fixed effects and controls for the distance to the nearest city. Therefore, the results are unlikely driven by the fact that the drought region was relatively rural.

[61] I present the results of estimating the regression with a split sample in the main text because these results are easier to interpret compared to one large interaction model. The interaction model is included in the Appendix. The estimated difference in selection is right signed for all coefficients and statistically significant for (3+ Drought Years)×(>11th grade education)×(severe Depression).

As in Equation 3, the coefficients of primary interest are contained in the vectors β_2, β_3, and the summation of β_2 and β_3. The coefficients in β_2 estimates the difference between the propensity to move to non-city locations for the omitted group (individuals with less than an 8th grade education) from drought counties relative to similar migrants from non-drought counties. The coefficients in β_3 estimate whether more highly educated migrants from drought counties moved to non-city destinations more often than the omitted category. The sum of a coefficient in the vector β_2 and the corresponding coefficient in the vector β_3 estimates whether more highly educated drought migrants moved to non-city destinations more than migrants in the same education category from a non-drought county.

Column 1 of Table 13 displays the results of estimating Equation 4 for the entire sample of migrants. The coefficient for *three or more drought years* indicates that migrants with less than an 8th grade education from drought counties were 4.2 percentage points more likely to relocate to non-city destinations compared to similar migrants from non-drought counties. As in the selection results, Figure 20.a. plots the sum of the coefficients for the impact of additional drought years (for the omitted category) and the relevant interaction term between drought years and education category to compare migrants (from drought and non-drought counties) of the same education category. Figure 20.a. shows that migrants from counties with three or more drought years went to non-city destinations more often than their counterparts from non-drought counties across all education categories. Overall, Table 13 and Figure 20 show that migrants from drought counties were less likely to relocate to city destinations compared to other migrants. This result is interesting in light of previous literature stressing urbanization as an outcome of climate shocks. A possible explanation for this sorting pattern is put forth in the discussion section of this chapter.

Table 13: Propensity of migrants to move to non-city destinations by education and drought

	(1) Non-city migrant	(2) Non-city migrant	(3) Non-city migrant
8th to 11th grade ed.	-0.091***	-0.092***	-0.087***
	(0.005)	(0.009)	(0.005)
> 11th grade ed.	-0.179***	-0.164***	-0.186***
	(0.007)	(0.011)	(0.006)
2 drought years	0.003	0.060***	-0.007
	(0.011)	(0.019)	(0.011)
3+ drought years	0.042**	0.062**	0.044***
	(0.016)	(0.027)	(0.012)
(2 drought years)×(8th to 11th)	0.017**	-0.002	0.021***
	(0.007)	(0.011)	(0.007)
(3+ drought years)×(8th to 11th)	0.024***	-0.011	0.024***
	(0.007)	(0.012)	(0.007)
(2 drought years)x(> 11th)	0.002	-0.018	0.007
	(0.008)	(0.016)	(0.008)
(3+ drought years)×(> 11th)	0.004	-0.034**	0.018*
	(0.009)	(0.013)	(0.009)
Observations	6,698,862	2,705,873	3,992,989
Sample	All migrants	Non-city origins	City origins

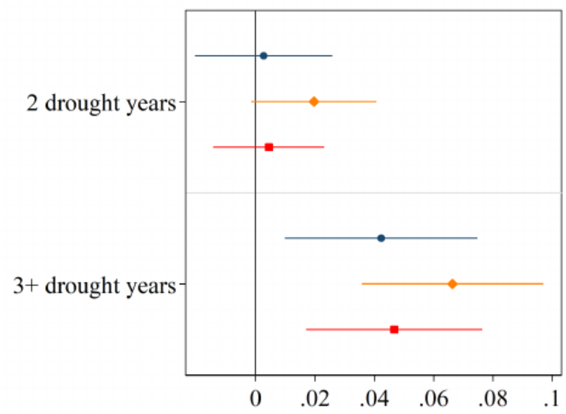
Standard errors clustered by 1935 state in parentheses

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

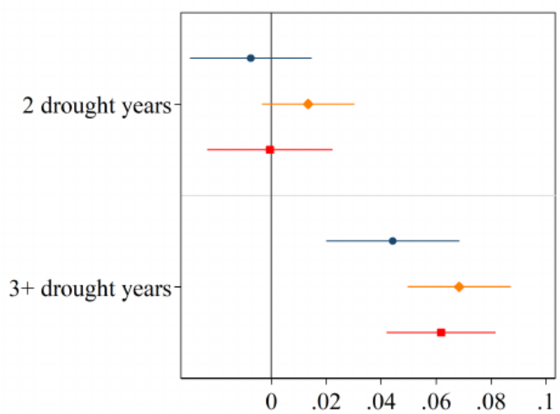
Notes: These results estimate whether migrants from drought counties were more likely to move to non-city destinations compared to other migrants. The coefficient in the fourth row of column 1 of shows that migrants with less than an 8th grade education from counties with three or more drought years were 4.2 percentage points more likely to relocate to non-city destinations relative to similar migrants from non-drought counties. The fifth and sixth rows of column 1 show that individuals with an 8th to 11th grade education from drought counties were even more likely to move to non-city destinations. Columns 2 and 3 distinguish by non-city and city origins. The higher propensity to move to non-city destinations holds for migrants from non-city and city origins. Sample includes adults (25 to 65 in 1935). Regressions include age and state fixed effects, and individual and county controls as discussed in the context of Equation 4. Regressions include distance to the nearest city as a control.

To show that this increased propensity for non-city destinations among migrants from drought counties held for both migrants from non-city and city origin locations, columns 2 and 3 of Table 13 and Figures 20.b. and 20.c. disaggregate the sample of migrants. Figure 20.b. shows that migrants from non-city origins with the three or more drought years were more likely to relocate to non-city destinations. Figure 20.c. shows that migrants from city origins in drought

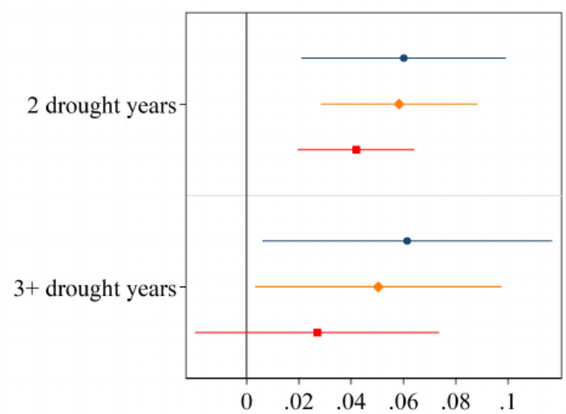
Figure 20: Propensity of migrants to move to non-city destinations by education and drought



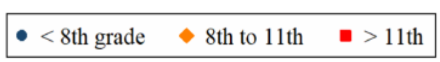
(a) All migrants



(b) Non-city origins



(c) City origins



Notes: These are the results correspond to Table 13. The coefficients in these figures are the estimated impact of drought years on the propensity of migrants to move to non-city locations relative to observably similar migrants from non-drought counties. As an example of how to interpret the magnitudes of these coefficients, the last coefficient in (a) estimates that individuals with greater than an 11th grade education and from a county with three or more years of drought were 4.6 percentage point more likely to migrate to a non-city destination than individuals of the same education level from non-drought counties. Both migrants from non-city and city origins in drought counties had a higher propensity to move to non-city locations compared to other migrants as seen in (b) and (c). These regressions include distance to the nearest city as a control.

counties displayed a higher propensity for non-city destinations from both counties with two drought years and three or more drought years. This choice of for non-city destinations among migrants from city origins in Figure 20.c., and the descriptive evidence that nearly 50 percent of migrants from cities relocated to non-city destinations in Figure 17, indicates that there was

Table 14: Propensity of migrants to move to different types of non-city destinations

	(1) Non-farm migrant	(2) Farm migrant	(3) Non-farm migrant	(4) Farm migrant
8th to 11th grade ed.	0.028***	-0.112***	-0.035***	-0.057***
	(0.007)	(0.010)	(0.005)	(0.005)
$>$ 11th grade ed.	0.052***	-0.235***	-0.063***	-0.101***
	(0.013)	(0.015)	(0.006)	(0.007)
2 drought years	0.001	-0.011	0.034***	0.022**
	(0.009)	(0.012)	(0.011)	(0.011)
3+ drought years	0.026	0.019	0.046**	0.023***
	(0.016)	(0.019)	(0.019)	(0.008)
(2 drought years)$\times$(8th to 11th)	-0.012	0.035***	0.002	-0.002
	(0.008)	(0.011)	(0.011)	(0.007)
(3+ drought years)$\times$(8th to 11th)	-0.010	0.033**	-0.008	-0.005
	(0.010)	(0.014)	(0.009)	(0.005)
(2 drought years)$\times$($>$ 11th)	-0.000	0.012	0.004	-0.020*
	(0.015)	(0.018)	(0.010)	(0.012)
(3+ drought years)$\times$($>$ 11th)	0.028	-0.013	-0.006	-0.030***
	(0.018)	(0.023)	(0.012)	(0.009)
Observations	3,990,559	3,990,559	2,705,873	2,705,873
Sample	Non-city origins	Non-city origins	City origins	City origins

Standard errors clustered by 1935 state in parentheses

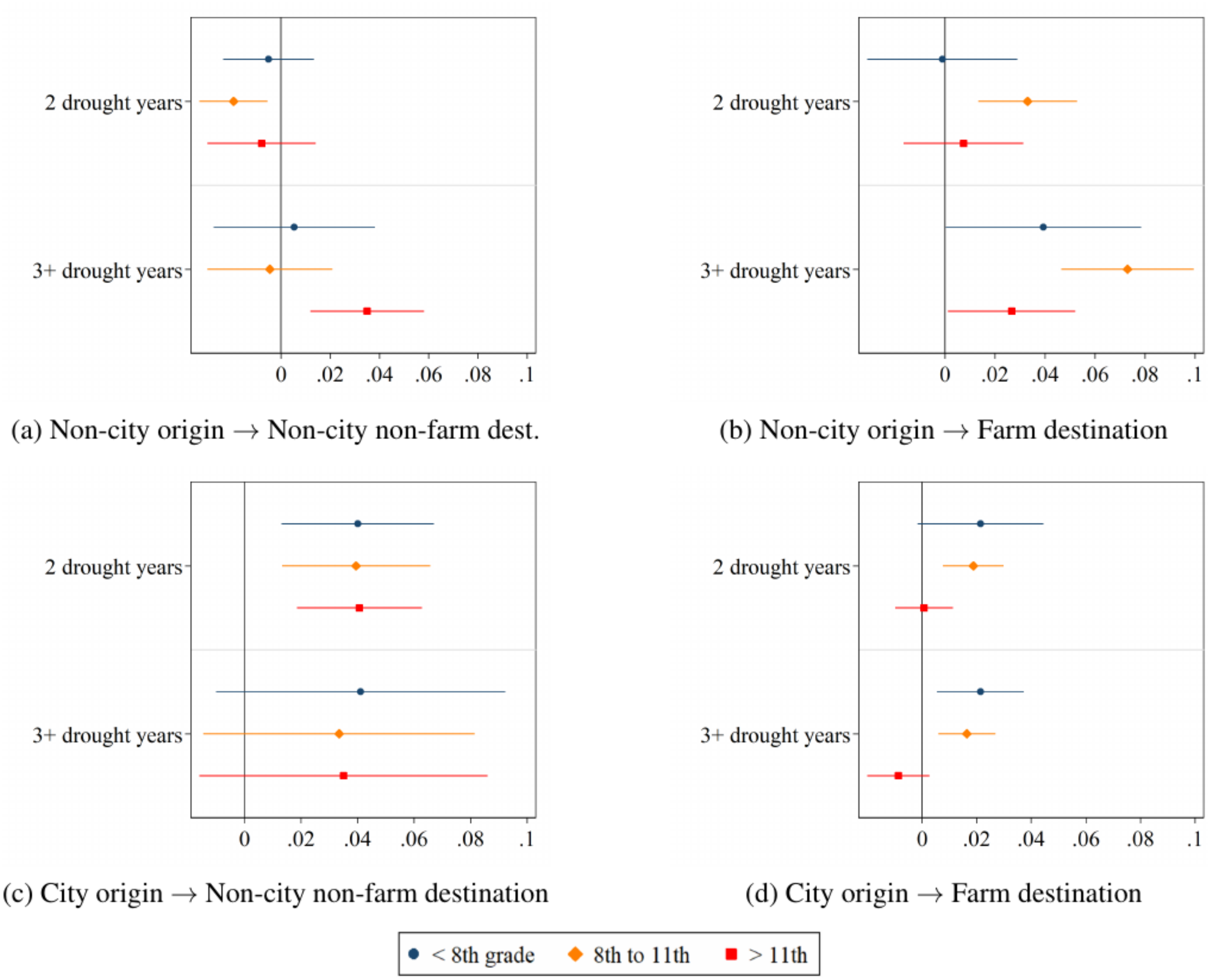
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: These results disaggregate the results that drought migrants were more likely to move to non-city destinations into non-farm and farm destinations. There was heterogeneity in type of non-city destination based on individual education attainment and type of origin location (non-city or city). These results are displayed in Figure 21 as a comparison between the migration propensities within education categories for ease of interpretation. Regressions include age and state fixed effects, and individual and county controls as discussed in the context of Equation 4. These regressions include distance to the nearest city as a control.

substantial movement out of cities through the late 1930s and that drought encouraged this trend on the margin.

Finally, to better understand where migrants were going, Table 14 and Figure 21 disaggregate non-city destinations into two mutually exclusive subsets (non-farm and farm destinations) separately for migrants from non-city origins and migrants from city origins. Figure 21.a. shows that highly educated migrants originating from non-city locations in counties

Figure 21: Propensity of migrants to move to different types of non-city destinations



(a) Non-city origin → Non-city non-farm dest.

(b) Non-city origin → Farm destination

(c) City origin → Non-city non-farm destination

(d) City origin → Farm destination

Notes: These results correspond to Table 14. The coefficients in these figures are the estimated impact of drought years on the propensity of migrants to move to different types of non-city destinations. Highly educated drought migrants and drought migrants who started in cities more often relocated to small town and non-farm destinations as seen in (a) and (c). Less educated drought migrants more often relocated to farm destinations as seen in (b) and (d). Regressions include age and state fixed effects, and individual and county controls as discussed in the context of Equation 4. These regressions include distance to the nearest city as a control.

that suffered three or more drought years were disproportionately likely to move to non-farm locations. These small towns and unincorporated residences were also popular among migrants from drought cities across the educational spectrum as shown in subfigure (c). By contrast, farm destinations were more popular among less educated migrants from both non-city and city origins.

These results show that there was considerable heterogeneity in destination choice based on drought exposure and education attainment. Overall, migrants from drought counties tended to avoid cities to a great extent than other migrants. This was true for drought migrants who started in city and non-city locations. There was also heterogeneity in the type of non-city destination by education attainment. Less educated migrants from drought counties more often relocated to farm destinations compared to similar migrants from non-drought counties. Better educated migrants, and all migrants who started in cities, were more likely to relocate to non-farm destinations. This result shows that there was more movement back into or between agricultural jobs for less educated people compared to individuals with a high school education or higher.

Discussion

This chapter shows that drought heterogeneously impacted migration in terms of who moved and where migrants went. My results complement and expand on previous research by analyzing the environmental shock of drought during the 1930s, expanding the geographic area of focus, and studying selection in a new light. Previous research on selection into migration focuses whether the *average* migrant from impacted counties was positively or negatively selected.[62] I study whether drought led to more migration for individuals based on their education attainment. That is, my approach provides a direct measure of how an environmental shock impacted individual migration propensities.

The result that drought induced more migration only for highly educated individuals contrasts (in some ways) with the narratives popularized by John Steinbeck, Dorothea Lange, and

[62] I discuss this distinction further in the Appendix, and show that although drought induced more migration among the highly educated, the average migrant from drought counties was neither more positively nor negatively selected compared to the average migrant from non-drought counties.

Woodie Guthrie. Typically, migrant families have been portrayed as destitute: struggling on the road and at their destinations. I show that drought induced migration primarily among highly educated individuals who were likely to be comparatively affluent. Today there exists a similar tension between the popular perception of climate migrants and empirical findings on the composition of migrants. The development economics literature shows that migration away from environmental shocks mostly occurs in middle income and higher countries (Cattaneo and Peri 2016) and for middle income and higher towns (Bazzi 2017). Although empirical results show that environmental shocks, tend to induce more migration only among the relatively affluent, environmental shocks also are likely to make travel conditions harder for migrants. This added hardship is likely most intensely felt by migrants with little wealth or human capital, and is perhaps what is captured by Steinbeck and Lange (among others).

Understanding that climate shocks can induce positive selection into migration is important because if climate migrants are positively selected from their origin population, and deflecting costs through migration, those who do not have the means to move might be the more vulnerable subset of the population. Furthermore, highly educated individuals disproportionately migrating away from environmental shock creates a secondary shock for those who remain behind, as non-migrants deal with the impact of the environmental degradation and withdrawal of community members with the means to leave. This secondary shock may be either harmful or beneficial to non-migrants as discussed in the next chapter.

In terms of where migrants went, the majority of migrants in the late 1930s moved from non-city locations to other non-city locations. Additionally, almost half of all migrants who started in cities moved to non-city destinations. In the context of drought, migrants from drought counties were *less* likely to move to cities compared to similar migrants from non-drought counties. This result largely held for people of all education categories, suggesting that there was an intensive adjustment in migration decisions that occurred across the education distribution in response to drought. That is, although individuals with less human capital did not more in response to drought, they did change their migration decisions in terms of destination choice.

Examining why migrants from drought counties were more inclined to move to non-city destinations is a topic for future inquiry. Still, a possible explanation is discussed here. Potentially, droughts impacted both industrial production and heat related illnesses in cities to a greater extent than in non-city locations. These impacts combined with the fact that the economic downturn of the Great Depression was concentrated in cities might have driven migrants from drought counties to disproportionately avoid cities. This explanation echoes the back-to-the-land movement from Depression stricken cities (Schultz 1948, Todara 1969, Boyd 2002). Yet the back-to-the-land movement was traditionally believed to have occurred in the early 1930s from the worst impacted cities in the Great Depression. I show that there was considerable movement out of large metropolitan areas through the late 1930s.

CHAPTER 7

ECONOMIC RESPONSES TO DROUGHT 3: LABOR MARKET TRANSITIONS AND OUTCOMES

A leading factor in someone's decision to move is their perception that there are better employment opportunities in a location other than their own. But migration is fundamentally a risky investment and employment outcomes vary on an individual basis and depend on the time and place of migration. Perceived opportunities that drive migration, do not guarantee that better opportunities are realized on average, let alone for each migrant. To analyze how migrants fared, this chapter studies labor market transitions and outcomes for men from 1930 to 1940 with an emphasis on how migration and drought influenced labor market outcomes.

Question concerning migrant outcomes are especially interesting in the stressed labor markets of the Great Depression, and in the context of literature on migration from the Dust Bowl that emphasizes the economic difficulties faced at destinations (Riney-Kehrberg 1989, Worster 2004, Hornbeck 2020). Both the context of the Great Depression and prejudice against migrants may have contributed to poor employment opportunities, yet there is little research that systematically evaluates migrant outcomes. This chapter expands on previous research by studying the economic outcomes of drought migrants and all migrants heterogeneously by individual education.

Migrant outcomes are evaluated compared to non-migrants in this chapter. Furthermore, it is important to contextualize the results for migrants in light of the fact that, even in the worst impacted drought counties, most people stayed. Therefore, this chapter also analyzes the labor market outcomes of non-migrants distinguishing by drought exposure to form a basis for evaluating migrant outcomes and to study how persisters fared. Evaluating the economic prosperity of non-migrants is intriguing because of the timing of the 1940 census. Drought had largely subsided and optimism was high on the Great Plains by 1940. Therefore, on one hand, we might expect that employment and economic opportunities in drought counties recovered quickly after the drought ended, especially in the context of labor markets that had witnessed substantial declines in total population. On the other hand, people who stayed in drought counties might have continued to struggle economically in 1940 because of complications that arose from numerous drought years (increased debt, lack of investment in new equipment, poor health, continued erosion problems, etc.).

To study labor market outcomes, this chapter uses the linked sample of men from the 1930 to the 1940 census and the drought data described in Chapter 3. To evaluate how migration and drought impacted labor market outcomes, I estimate linear regressions that compare the labor market outcome variables of migrants and non-migrants while distinguishing by education attainment and drought conditions at their origin county.

The results of this chapter should be interpreted carefully and foremost as descriptive differences in employment opportunities between migrants and non-migrants rather than as the causal impacts of migration. It is likely that there was unobserved negative selection into migration and that this unobserved selection accounts for some of the differences in labor market outcomes between migrants and non-migrants. This is especially true for the estimated differences in employment status discussed in the next paragraph. I observe employment status only at the date of census enumeration in 1930 and again in 1940, and unemployment during the 1930s was likely correlated with individuals' decisions to move. Therefore, the estimated differences between employment status of migrants and non-migrants in 1940 is possibly driven, in part, by migrants having been more likely to be unemployed at the time of their move. I take a number of steps, including an analysis of migrant and non-migrant brothers and an analysis of the stability of coefficients, to alleviate concerns of omitted variable bias (OVB).

I find that migrants were less likely to be employed compared to similar non-migrants in 1940. On average, migrants were 4.9 percentage points less likely to be employed compared to a similar non-migrant. Moreover, when migrants were employed, on average they did not make any more in wages than similar non-migrants from their origin county. The poor economic performance of migrants was true for migrants from drought counties and non-drought counties alike, showing that the lack of economic opportunity for migrants was widespread, not unique or especially pronounced, among migrants who started the decade in drought counties.

Nonetheless, there was heterogeneity in migrant outcomes based on individual education. The gap between employment status for migrants and similar non-migrants was smaller for men with more education. Migrants with a high school education or higher were only 2.7 percentage points less likely to be employed compared to similar non-migrants. Moreover, when men with a high school education or higher found work, it usually paid more than that of similar non-migrants. Migrants with a high school education were making 8.2 log percentage points more in wages compared to similar non-migrants. There was also heterogeneity in returns to migration by age as the restricted sample for the *brother analysis* shows. Younger migrants (aged 14 to 18 in 1930) were earning more than similar non-migrants in 1940 regardless of education level.

These findings on migrant outcomes contribute literature on migration from environmental disasters and Depression-era migration literature on a number of dimensions. First, because of the negative consequences of environmental shock on personal finances, climate migrants might not be able to make as good of migration choices as other migrants. But in the 1930s, the labor market outcomes of drought and non-drought migrants look similar.[63] This indicates that drought migrants were able to make comparable moves to other migrants during the 1930s. Nonetheless, this result should be interpreted in the context of poor labor market outcomes for migrants, specifically for migrants with little education. Migration is always a risky investment with uncertain returns (Harris and Todaro 1970, Stark and Levhari 1982, Katz and Stark 1986), and the poor performance of migrants with little education during the 1930s highlights the differential returns to migration base on skill and suggests that risks may be attenuated during economic downturns.

The finding that migrants with little education were less likely to be employed and had lower wages than similar non-migrants in 1940, introduces the question of why men with little education migrated if returns were so poor. One explanation is that OVB is particularly strong for this group, and that gaps in employment and wages would have existed whether or not these men migrated. Perhaps, either in connection with OVB or separately, men of different backgrounds engaged in different *types* of migration. Less affluent men, more often with little education, might have engaged in *survival migration* in which the objective was simply to extricate themselves from desperate situations, whereas more affluent men more commonly engaged in *investment migration* in which they expected positive returns on their investment (Kleemans 2015).

Finally, despite the drought, most people persisted in their origin county as discussed above. Therefore, I analyze the labor market outcomes of non-migrants. I find that men who stayed in drought counties through the decade were doing well in terms of employment status and wage income compared to non-migrants from non-drought counties in 1940. This result indicates that

[63] Moreover, historical literature on migrants from the Dust Bowl stresses the prejudice that Dust Bowl migrants faced at their destinations. But, in terms of labor market outcomes, migrants, regardless of drought status at their origin, struggled. This shows that in spite of bias directed at a particular subset of migrants, migrants faced similarly bad labor market prospects.

there may have been a robust and rapid recovery for the drought counties. Potentially, the net decline in the population from these counties witnessed in the second half of the decade created job opportunities for those that stayed. It is critical, however, to evaluate this result understanding that these labor market outcomes are a snapshot of conditions at a single point in time rather than an evaluation of total prosperity for individuals before and after the 1940 census. Moreover, it is also likely that many of the men that became unemployed during the 1930s moved away from the county as discussed above. Therefore, the relatively good labor market outcomes for the drought counties might be driven by the fact that men with the best or most secure jobs where those who remained in 1940.

Labor market transitions

To build an understanding of the distribution of labor among occupational categories, Table 15 is an occupational transition matrix for the linked sample of men. This table includes men aged 20 to 60 in 1930 that were linked between the 1930 and 1940 census (as detailed in Chapter 3) and who listed occupations in both 1930 and 1940. Table 15 (and all results in this chapter) weight observations by the inverse of the likelihood that an individual was linked as described in Chapter 3 and in the Appendix. Panel A includes the entire linked sample, and Panels B through E disaggregate labor market transitions between migrants and non-migrants and between drought and non-drought counties.

Over the 1930s, there was a shift into labor and out of craft, sales, operative, and farming occupations for the sample population. These trends hold for the entire linked sample (Panel A) and for subsets of the population distinguishing by migration and drought at their origin county (Panel B through E). In fact, the labor market distributions in 1930 and the transitions look similar

Table 15: Occupation transition matrix for men working in 1930 and 1940

	Distribution in 1930	Labor in 1940	Craft/sales /operative in 1940	Professional/ clerical in 1940	Farmer in 1940	Farm labor in 1940	Distribution in 1940
Panel A: Full linked sample *N = 2,148,320*							
Labor	14.4	7.8	4.2	1.0	0.7	0.7	21.8
Craft/sales/operative	39.5	7.1	25.5	5.3	1.0	0.6	36.2
Professional/clerical	19.7	2.3	4.0	12.8	0.4	0.1	20.1
Farmer	19.6	2.9	1.5	0.7	13.1	1.4	17.5
Farm labor	6.8	1.7	1.1	0.3	2.2	1.6	4.3
Panel B: Migrants from drought counties *N = 275,959*							
Labor	14.3	6.1	4.3	1.2	1.6	1.2	23.1
Craft/sales/operative	35.9	6.7	19.8	5.9	2.5	1.0	34.0
Professional/clerical	19.0	2.4	4.3	11.3	0.8	0.3	20.2
Farmer	20.3	4.9	3.2	1.2	8.5	2.3	15.9
Farm labor	10.6	3.0	2.4	0.6	2.4	2.1	6.9
Panel C: Non-migrants from drought counties *N = 918,820*							
Labor	13.9	7.8	4.1	0.9	0.5	0.5	20.5
Craft/sales/operative	36.8	6.5	24.6	4.5	0.7	0.4	34.2
Professional/clerical	17.8	2.0	3.4	12.0	0.4	0.1	18.4
Farmer	24.8	2.8	1.3	0.7	18.8	1.3	23.2
Farm labor	6.8	1.4	0.8	0.2	2.8	1.6	3.8
Panel D: Migrants from non-drought counties *N = 217,042*							
Labor	14.7	6.8	4.4	1.3	1.1	1.1	23.9
Craft/dales/operative	42.3	8.1	24.0	7.2	1.8	1.1	37.8
Professional/clerical	23.1	3.1	5.3	13.7	0.7	0.3	23.7
Farmer	12.6	3.5	2.3	0.9	4.3	1.5	9.1
Farm labor	7.4	2.3	1.8	0.5	1.2	1.5	5.5
Panel E: Non-migrants from non-drought counties *N = 725,340*							
Labor	15.1	8.8	4.2	1.0	0.5	0.7	22.3
Craft/sales/operative	43.3	7.6	29.1	5.4	0.7	0.5	39.2
Professional/clerical	21.2	2.5	4.2	14.0	0.3	0.1	21.1
Farmer	15.1	2.0	1.0	0.5	10.6	1.0	13.8
Farm labor	5.3	1.4	0.7	0.2	1.6	1.4	3.7

Notes: This table displays the percent of men in each occupation category for men in the linked sample who were working in both 1930 and 1940 (aged 20 to 60 in 1930). Panel A displays the labor market transitions for the entire linked sample. Panels B through E disaggregate by drought and migrant status. There was a shift into *labor* during the 1930s. This pattern held regardless of drought and migrant status. Mostly, the transition matrices look similar regardless of migrant and drought status with few exceptions discussed in the text. The fraction in each occupation category are weighted based on inverse probability of linkage.

regardless of migrant and drought status with a few exceptions discussed below. Also, note that the sample population is aging through this time period. In 1930 the sample is of 20- to 60-year-old men but in 1940 the same sample is of 30- to 70-year-old men.

As for difference between labor market transitions by migrant and drought status, first, there were more men employed as farmers, and as farm labor in drought counties (Panels B and C) compared to non-drought counties (Panels D and E) where more men were employed in crafts, sales, operative, professional, and clerical positions in 1930. This is consistent with the fact that the drought impacted largely agricultural portions of the country as discussed in Chapter 3. Second, for both drought and non-drought counties, men who were farmers in 1930 made up a considerably larger share of the labor market for non-migrants compared to migrants, which indicates that farmers were less likely to migrate compared to other occupational categories. The opposite was true for men employed in labor and farm labor in 1930, as these occupations made up a larger share among migrants compared to non-migrants, indicating that individuals employed in labor or farm labor were relatively more likely to move.

This chapter also distinguishes between education attainment when evaluating outcomes. To this end, Table 16 shows the typical occupations of employed men by their education attainment. Men with less than an 8th grade education were predominantly employed in labor, crafts, sales, operative, and farm occupations in both 1930 and 1940. Men with an 8th to 11th grade education were mostly employed in craft, sales, and operative positions but were fairly well represented across the occupational spectrum. Lastly, men with a high school education or higher mostly worked in craft, sales, operative, professional, and clerical positions. For all education categories there was a movement into *labor* during the 1930s. Taken together, there were

Table 16: Occupation transition matrix by education for men working in 1930 and 1940

	Distribution in 1930	Labor in 1940	Craft/sales /operative in 1940	Professional/ clerical in 1940	Farmer in 1940	Farm labor in 1940	Distribution in 1940
Panel A: < 8th grade *N = 564,489*							
Labor	20.7	12.4	5.2	0.8	1.1	1.2	31.0
Craft/sales/operative	35.8	9.0	22.5	2.4	1.2	0.7	32.3
Professional/clerical	7.2	1.8	1.8	3.1	0.3	0.1	7.1
Farmer	27.5	4.9	1.8	0.6	18.0	2.2	23.0
Farm labor	8.8	2.8	1.0	0.2	2.4	2.4	6.6
Panel B: 8th to 11th *N = 1,064,604*							
Labor	13.7	6.8	4.5	1.1	0.7	0.6	19.9
Craft/sales/operative	44.4	7.1	30.2	5.4	1.1	0.6	41.7
Professional/clerical	15.9	2.2	4.0	9.1	0.4	0.1	16.6
Farmer	19.1	2.3	1.7	0.7	13.1	1.2	17.8
Farm labor	7.0	1.5	1.3	0.3	2.4	1.5	4.0
Panel C: > 11th *N = 519,226*							
Labor	6.0	2.6	1.9	1.1	0.2	0.2	11.3
Craft/sales/operative	34.7	3.9	20.1	9.8	0.7	0.3	30.6
Professional/clerical	47.8	3.5	7.2	36.2	0.7	0.2	48.5
Farmer	8.2	0.9	0.8	0.9	5.2	0.4	8.0
Farm labor	3.4	0.5	0.7	0.4	1.3	0.5	1.5

Notes: This table displays the percent of men in each occupation category for men in the linked sample (aged 20 to 60 in 1930). Panel A displays the labor market transitions for men with less than an 8th grade education Panels B displays the transitions for men with an 8th to 11th grade education and Panel C displays the transitions for men with greater than an 11th grade education. The fraction in each occupation category are weighted based on inverse probability of linkage.

considerable differences in type of employment by education attainment, with more educated men employed in higher status occupations.

Overall, Tables 15 and 16 describes labor market transitions during the 1930s to provide an idea of the typical occupations of men, and shows some difference between men from drought and non-drought counties, between migrant and non-migrants, and education categories. Even so, Tables 15 and 16 provide coarse information concerning how well men were employed in 1930 and 1940 with regard to drought and migrant status, and do not control for important demographic characteristics such as age. To study the labor market outcomes of men more thoroughly, the next section estimates labor market outcomes for men based on their migration status and drought at their origin county.

Empirical framework

To study differences in labor market outcomes between migrants and non-migrants, I estimated the impact of migration on two labor market variables using the linear regression specified in Equation 5.

$$(5)\ L_{i1940} = \alpha + \beta_1 M_i + \beta_2 E_i + \beta_3 (M_i \times E_i) + \theta_1 X_{i1930} + \theta_2 X_{c1930} + \gamma_{l1930} + \gamma_a + \varepsilon_i$$

The outcome variable L_{i1940} is a variable measuring a characteristic of individual i's employment in 1940. I consider two different outcome variables: employment status (an indicator variable equal to one if the individual was employed in 1940) and the log of wage income. The labor market outcome variables are calculated based on data from the 1940 census. In separate equations, each labor market outcome variable is regressed on an indicator variable of migrant status (M_i) from 1930 to 1940, a vector with indicator variables for individual i's education attainment (E_i), a vector of the interaction terms between migrant status and education attainment ($M_i \times E_i$), a vector of 1930 individual characteristics (X_{i1930}), a vector of 1930 county characteristics (X_{c1930}), 1930 state, county, or household fixed effects (γ_{l1930}), age fixed effects (γ_a), and an error term (ε_i).

The indicator variable of migrant status (M_i) is equal to one if an individual moved from their origin county from 1930 to 1940. The vector of indicator variables for education attainment (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 are individuals with less than an 8th grade education. The indicator variable for migrant status is interacted with the vector of variables for education attainment so that ($M_i \times E_i$)

contains indicator variables for migrants with an 8th to 11th grade education and migrants with a 12th grade education or higher. Migrants with less than an 8th grade education are the excluded group. The vector of 1930 individual controls (X_{i1930}) includes: indicator variables for employment status, farm status, city status, marital status, household head status, home ownership status, whether the individual was white, foreign born, and in their birth state, and a continuous variable for their occupational income score. The vector of 1930 county controls (X_{c1930}) includes: continuous variables for average age, average occupational income score, fraction male, fraction white, fraction in a city, fraction in their birth state, fraction foreign born, fraction married, fraction of home owners, fraction of adult men employed, fraction living on a farm, and population.

Throughout this chapter, I vary the extent to which individual and county controls and state or county fixed effects are included in the specifications to show the stability of the results to alternate specifications. Aged fixed effects are included in all regressions. Moreover, to move towards causal interpretations of the estimated coefficients, I estimate Equation 5 for a separate linked sample of young men (aged 14 to 18) who were still living with their parents in 1930.[64] This linked sample of young men enables me to estimate Equation 5 with household fixed effects, which control for inter-household variation. Finally, because Equation 5 uses a linked sample of individuals from the 1930 to the 1940 census, I weight all regression results by the inverse of the linking probability as discussed in Chapter 3.

Migrant outcomes

Table 17 reports the coefficients of β_1 and β_3 from estimating Equation 5 with the outcome variable of employment status (employed or not in 1940) for the sample of men who were in

[64] This linked sample of young men follows the same linking criteria as the linked sample of men (aged 20 to 60 in 1930) as detailed in Chapter 3.

Table 17: Employment by migrant status and education: drought origins

	(1) Employed in 1940	(2) Employed in 1940	(3) Employed in 1940	(4) Employed in 1940	(5) Employed in 1940	(6) Employed in 1940
Panel A: non-interaction models						
Migrant	-0.055***	-0.048***	-0.048***	-0.049***	0.011*	0.006
	(0.003)	(0.002)	(0.002)	(0.002)	(0.006)	(0.012)
Panel B: interaction models						
Migrant	-0.073***	-0.068***	-0.068***	-0.068***	-0.028	-0.057**
	(0.004)	(0.003)	(0.003)	(0.003)	(0.021)	(0.022)
(Migrant)×(8th to 11th)	0.019***	0.022***	0.022***	0.021***	0.040*	0.069***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.021)	(0.019)
(Migrant)×(> 11th)	0.037***	0.043***	0.043***	0.041***	0.049**	0.074***
	(0.004)	(0.003)	(0.003)	(0.003)	(0.020)	(0.021)
Observations	1,179,590	1,179,590	1,179,590	1,179,481	30,858	30,858
R^2	0.086	0.11	0.12	0.12	0.11	0.62
Controls	No	Yes	Yes	Yes	Yes	Yes
Geographic fixed effects	No	No	1930 state	1930 county	1930 county	1930 household
Sample	Full linked	Full linked	Full linked	Full linked	Brothers aged 14 to 18	Brothers aged 14 to 18
Implied coefficient bound ($\tilde{R} = 1.3 \times \hat{R}$) for Panel B						
Migrant				-0.063		
(Migrant)×(8th to 11th)				0.022		
(Migrant)×(> 11th)				0.045		

Standard errors clustered by 1930 state in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table shows the results of regressing employment status (employed or not) on migrant status for the sample of men who started in drought counties. Panel A reports the results for a model excluding education interaction terms. Panel B reports the results of the interaction model. The results in columns 1 through 4 use the linked sample of men (aged 20 to 60 in 1930). The results of columns 5 and 6 use the linked sample of young men (14 to 18 in 1930) to address the potential for OVB. Panel A shows that migrants were less likely to be employed than non-migrants. Likewise, the first row of Panel B shows that migrants with less than an 8th grade education were less likely to be employed compared to similar non-migrants. For example, the first coefficient in column 1 of Panel B estimates that migrants with less than an 8th grade education were 7.3 percentage points less likely to be employed than an observationally similar non-migrant. As education increased for migrants, so did the likelihood that they were employed as seen in the second and third rows of Panel B. Results are weighted by the inverse probability of linkage. All regressions include age fixed effects. Geographic fixed effects and controls are varied as discussed in the context of Equation 5 and in the text.

drought counties (counties which subsequently witnessed three of more drought years) in 1930. Panel A of Table 17 reports the results of estimating Equation 5 when excluding the interaction term. In doing so, Panel A shows that migrants were less likely to be employed compared to similar non-migrants. Panel B displays the results of estimating the model with the interaction term and shows that there was heterogeneity in migrant returns based on individual education.

Panel B of Table 17 shows that migrants with less than an 8th grade education were less likely to be employed compared to non-migrants from their origin location regardless of the exact specification (columns 1 through 4 of Panel B). But the gap in employment between migrants and non-migrants dissipated as education increased. For example, the first row of column 4, shows that migrants with less than an 8th grade education were 6.8 percentage points less likely to be employed compared to non-migrants with similar 1930 characteristics and from the same origin county. The third row of column 4, shows that migrants with a high school education or higher were 4.1 percentage points more likely to be employed compared to non-migrants with less than an 8th grade education or only 2.7 percentage point less likely to be employed compared to a high school education non-migrant from their origin county. In all, the high unemployment rates among migrants compared to non-migrants were concentrated among less educated migrants.

The concern in interpreting the results of Table 17 as the impact of migration on employment status is that unobserved selection into migration might drive the observed differences in employment outcomes. That is, unobserved factors (such as employment status during the 1930s) are likely correlated with employment status in 1940 and the decision to move during the 1930s. To address concerns on selection on unobservable characters driving the results, I take two steps.

First, I vary the included controls and fixed effects in columns 1 through 4 to show that the inclusion of observable variables has little impact on the estimated coefficients. Studying the sensitivity of treatment effects to the inclusion of observed controls is a common approach to assessing the potential bias from unobserved variables in economics. The intuition behind this approach is that the bias that arises from including observable controls is informative about the bias from unobservable variables. It is, however, not necessarily true that bias from observables is indicative of bias from unobservables, and the movement of R-squared is important to assessing how meaningful the inclusion of controls is (Altonji et al. 2005, Oster 2019). Therefore, the stability of the estimated coefficients in columns 1 through 4 is encouraging, but is not sufficient to determine whether migration was causing the observed differences in employment status. Therefore, the results of a coefficient stability analysis using the technique of Oster (2019) is reported at the bottom of Table 17. The bounds of coefficients for employment for adult men are very similar to those reported in the Table, showing that unobserved variables are unlikely to change the results in columns 1 through 4 of Panel B.

I further address the issue of unobserved bias driving the results in Table 17 by comparing outcomes between brothers. Comparing economic outcomes between siblings eliminates the inter-household component of migrant selection and thereby mitigates concerns of unobservable selection (Abramitzky et al. 2012, Collins and Wanamaker 2014). Column 6 of Table 17 reports the results of estimating Equation 5 with household fixed effects and restricting the sample to young men with brothers and living at their parents' house in 1930. Because the analysis of brothers is based on a different sample than the main sample of analysis for this chapter (including Table 17 columns 1 through 4), column 5 is included as a comparison group to column 6 using the controls and fixed effects of column 4.

The results from this alternate sample and specification are similar to the results for the sample of adult men (aged 20 to 60) in columns 1 through 4 when the results are disaggregating by education in Panel B. Young male migrants with less than an 8th grade education were more likely to be unemployed compared to their non-migrant brothers. But as education increased, migrants were more likely to be employed. In fact, young migrants with an 8th grade education or higher were more likely to be employed than their non-migrant brothers.

In total, Table 17 shows a distinct pattern for migrant employment status based on education level. Migrants with less than an 8th grade education were less likely to be employed at their destinations compared to similar non-migrants from their origin county. Migrants with higher education were more likely to be employed than less educated migrants, and, for young men, well-educated migrants had a higher likelihood of being employed than similar non-migrants. Although the exact magnitude of the impact of migration varies, all specifications follow this basic pattern.

Employment status (being employed or not) is a clear, simple, and basic measure of someone's labor market standing. But employment status tells little about how *well* someone is employed. A direct measure of occupational standing is income. To study the quality of employment, Table 18 displays the results of estimating the relationship between wage income and migrant status.

Table 18 follows the same format as Table 17. Panel A reports the estimates of Equation 5 without the interaction term to show how migrants were doing overall. Panel B reports the coefficients of the interaction regressions to show differential outcomes by education. Moreover, the first 4 columns estimate Equation 5 with different controls and fixed effects for the sample of men aged 20 to 60 in 1930. Then, columns 5 estimates Equation 5 with the sample of young men for comparison to column 6, which includes household fixed effects.

There are a couple of differences between the samples in Table 17 (employment status) versus Table 18 (wages). First, Table 18 includes only men employed in 1940. Therefore, differences in wages should be considered in light of the difference in likelihood employed from Table 17. Second, the 1940 census included information on wage income paid by employers only.

Table 18: Wages by migrant status and education: drought origins

	(1) Log 1940 wage	(2) Log 1940 wage	(3) Log 1940 wage	(4) Log 1940 wage	(5) Log 1940 wage	(6) Log 1940 wage
Panel A: non-interaction models						
Migrant	-0.169***	0.005	0.007	0.009	0.179***	0.181***
	(0.013)	(0.014)	(0.015)	(0.015)	(0.025)	(0.028)
Panel B: interaction models						
Migrant	-0.309***	-0.068***	-0.067***	-0.069***	0.169**	0.228**
	(0.024)	(0.020)	(0.021)	(0.021)	(0.079)	(0.095)
(Migrant)×(8th to 11th)	0.132***	0.071***	0.072***	0.075***	-0.016	-0.029
	(0.020)	(0.012)	(0.012)	(0.011)	(0.091)	(0.108)
(Migrant)×(> 11th)	0.282***	0.143***	0.144***	0.151***	0.030	-0.063
	(0.021)	(0.016)	(0.016)	(0.015)	(0.081)	(0.102)
Observations	588,331	588,331	588,331	588,160	12,406	12,406
R^2	0.15	0.35	0.35	0.37	0.28	0.68
Controls	No	Yes	Yes	Yes	Yes	Yes
Geographic fixed effects	No	No	1930 state	1930 county	1930 county	1930 household
Sample	Full linked	Full linked	Full linked	Full linked	Brothers age 14 to 18	Brothers age 14 to 18
Implied coefficient bound ($\tilde{R} = 1.3 \times \hat{R}$) for Panel B						
Migrant				0.053		
(Migrant)×(8th to 11th)				0.047		
(Migrant)×(> 11th)				0.088		

Standard errors clustered by 1930 state in parentheses

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

Notes: This table shows the results of regressing log wage income on migrant status for the sample of men who started in drought counties. Panel A reports the results for a model excluding interaction terms. Panel B reports the results of the interaction model. The results in columns 1 through 4 use the linked sample of men (aged 20 to 60 in 1930). The results of columns 5 and 6 use the linked sample of young men (14 to 18 in 1930) to address the potential for OVB. Panel A shows that adult migrants and non-migrants earned similar amounts once controlling for individual and county characteristics (columns 2 through 4). Panel B shows that there was heterogeneity in migrant wages by education. As education increased for migrants, so did wage income as seen in the second and third rows of Panel B. The first row of columns 5 and 6 show that, for young men, migrants earned more than non-migrants. Results are weighted by the inverse probability of linkage. All regressions include age fixed effects. Geographic fixed effects and controls are varied as discussed in the context of Equation 5 and in the text.

That is, wage income data does not include wages from self-employment (including farming). As such, the estimates in Table 18 do not include self-employed men.[65] Because of this, I use an alternate measure of occupational standing (*occupational income score)* in the appendix as a

[65] I explicitly exclude farmers and all individuals who are not identified as working for wages using the IPUMS variable *classwkr*.

robustness check. The results of estimating the relationship between migration status, education, and occupational income score are consistent with the results for wage income presented here.

The results of Table 18 Panel A, columns 1 through 4, show that employed migrants had about the same wage income as non-migrants after controlling for observables. This result should be considered in light of Table 17, which shows that migrants were less likely to be employed than non-migrants. The results in columns 5 and 6 restrict the sample to younger men and show that young migrants had higher wages compared to similar non-migrants.

Panel B of Table 18, shows that there were heterogeneous returns to migration in terms of wage income based on education attainment for the sample of adult men. The results of Panel B columns 1 through 4 show that migrants with less than an 8th grade education earned less in 1940 compared to similar non-migrants. This negative relationship between wages and migration dissipated as education increased. For example, column 4 shows that migrants with less than an 8th grade education were earning 6.9 log percentage points less in wages in 1940 compared to similar non-migrants from their origin county. Yet, migrants with a high school education or higher were making 15.1 log percentage points more than non-migrants with less than an 8th grade education or 8.2 log percentage points more than non-migrants with a high school education or higher. There is substantial variation in the estimated coefficients based on the inclusion of controls. Given this variation, the Oster (2019) analysis reported at the bottom of column 4 suggests that the low wages observed for migrants with less than an 8th grade education might be due to OVB.

Moreover, the same pattern of worse wages for migrants with less than an 8th grade education and better wages for more educated migrants does not hold when the sample is restricted to younger men as in columns 5 and 6. Instead, the first row of Panel B columns 5 and 6 shows that younger migrants obtained higher wages, regardless of educational background. These results show differential returns to migration based on age, with young migrants doing considerably better than non-migrants.

Young migrants had different wage outcomes compared to older men, but the results of columns 5 and 6 in Table 18 are still helpful in evaluating whether the results for older men (columns 1 through 4) are simply descriptive differences or closer to causal estimates. Both the estimates using samples of young men indicate the same basic outcome: young migrants received higher wages on average if they were able to find work. The consistency between estimation strategies in columns 5 and 6 is suggestive that the basic pattern for older migrants (of higher wages for migrants with better education) will hold as causal interpretations with uncertain magnitudes.

In summary, Tables 17 and 18 estimate the economic outcomes of migrants from drought counties based on education and compared to non-migrants at their origin location. Migrants (aged 20 to 60 in 1930) with less than an 8th grade education were both less likely to be employed and were earning less (when they were employed) compared to similar non-migrants. More highly educated migrants did better in terms of employment and wages compared to migrants with less than an 8th grade education. Younger migrants (aged 14 to 18 in 1930) followed a similar pattern in terms of employment status by education attainment, but young migrants were paid better than similar non-migrants regardless of their education attainment. Taken together, these results show differential returns to migration based on education and age.

Tables 17 and 18 focus on outcomes for migrants who started the decade in drought counties. But migrants originating from drought counties constituted only half of all migrants. Furthermore, the outcomes of migrants from non-drought counties are an interesting comparison

Table 19: Employment and wages by migrant status: drought versus non-drought origins

	(1) Employed in 1940	(2) Employed in 1940	(3) Employed in 1940	(4) Log 1940 wage	(5) Log 1940 wage	(6) Log 1940 wage
Migrant	-0.051***	0.011*	0.007	0.003	0.178***	0.187***
	(0.002)	(0.006)	(0.012)	(0.015)	(0.024)	(0.028)
(Migrant)×(non-drought origin)	0.007*	0.005	0.028	0.018	-0.047	-0.065
	(0.004)	(0.011)	(0.018)	(0.016)	(0.031)	(0.039)
Observations	2,118,507	52,358	52,358	1,117,443	22,196	22,196
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	1930 county	1930 county	1930 household	1930 county	1930 county	1930 household
Sample	Full linked	Brothers aged 14 to 18	Brothers aged 14 to 18	Full linked	Brothers aged 14 to 18	Brothers aged 14 to 18

Standard errors clustered by 1930 state in parentheses

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

Notes: This table shows the results of regression labor market outcomes (employment status and wage income in 1940) on migrant status interacted with drought status. Overall, migrants from drought counties did not have different labor market outcomes compared to migrants from non-drought counties. The results in columns 1 and 4 use the linked sample of men (aged 20 to 60 in 1930). The results of columns 2, 3, 5, and 6 use the linked sample of young brothers (14 to 18 in 1930). Results are weighted by the inverse probability of linkage. All regressions include age fixed effects. Geographic fixed effects and controls are varied as discussed in the context of Equation 5 and in the text.

because drought impacted the decision to migrate, destination choice, and, likely, the finances of migrants. Conceivably, migrants from drought counties had different labor market outcomes compared to migrants from non-drought counties.

To study whether migrant outcomes varied based on drought or non-drought origin status, Table 19 displays the results of estimating a modified version of Equation 5. In Table 19 migrant status is interacted with non-drought origin status rather than education.[66] Depending on the sample and specification, there were some differences in labor market outcomes for migrants based on drought status at their origin county. For example, adult migrants from non-drought counties were 0.7 percentage points more likely to be employed than migrants from drought counties as seen in the second row of column 1. But overall, migrants from drought counties were not doing

[66] The indicator variable for drought status equals one if a county experienced three or more drought years (*drought counties*) and equals zero otherwise (*non-drought counties*). For Table 19, education attainment is not interacted with migrant and drought status for simplicity and clarity. Education attainment is still controlled for in Table 19. I estimate a triple interaction model below which replicates these results.

Table 20: Employment and wages compared to non-migrants at destinations

	(1) Employed in 1940	(2) Log 1940 wage
Migrant	-0.064***	-0.087***
	(0.003)	(0.010)
(Migrant)×(8th to 11th)	0.020***	0.059***
	(0.002)	(0.009)
(Migrant)×(> 11th)	0.038***	0.127***
	(0.002)	(0.009)
Observations	2,118,507	1,117,483
R^2	0.12	0.38
Controls	Yes	Yes
Fixed effects	1940 county	1940 county

Standard errors clustered by 1930 state in parentheses

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

Notes: This table shows the results of regressing labor market outcomes (employment status and wage income) on migrant status interacted with education compared to non-migrant at the destination county. These results show that the differences in migrant and non-migrant employment and wages seen in Tables 17 and 18 are also apparent when comparing migrant outcomes to non-migrants at their destination county. These results use the linked sample of men (aged 20 to 60 in 1930). Results are weighted by the inverse probability of linkage. Regressions include age and 1940 county fixed effects. Individual controls are included as discussed in the context of Equation 5.

decisively worse (or better) than migrants from non-drought counties as discussed further in the *Discussion* section of this chapter.

The results of Tables 17 through 19 are based on comparisons of migrants' labor market outcomes to those of non-migrants at *origin* locations. Another comparison is how migrants were doing compared to non-migrants at the migrants' *destination* location. Comparing migrant outcomes to those of non-migrants at their destination sheds light on whether the observed differences between migrants and non-migrants were a function of the attributes of destination locations or differences in labor market assimilation rates. If it was the case that migrants had worse outcomes than non-migrants at their origin locations because of overall labor market conditions at destinations, then we expect the labor market outcomes of migrants to look similar to those of non-migrants at their destinations.

Table 20 displays the results of estimating Equation 5 for employment status (column 1) and wage income (column 2) with destination county fixed effects for the sample of adult men. Table 20 shows the same pattern for migrant outcomes as seen when comparing migrants to non-migrants at their origin county. Migrants with less than an 8th grade education were less likely to be employed and were paid less when they did find work compared to non-migrants at their destination counties. Migrants with higher education did better in terms of both finding work and wages. These results show that the labor market outcomes of migrants were unlikely to have been driven by worse overall labor market conditions at their destination counties.

Non-migrant outcomes

Even in the counties most impacted by drought, most people did not move. For example, in the linked sample of men used for this chapter, 5 hundred thousand moved while 1.6 million did not. Therefore, studying the labor market outcomes of non-migrants is important to understanding the overall impact of drought and the outcomes for migrants. To study how non-migrants were doing in 1940, I estimated the impact of drought on employment and wages using a modification of Equation 5.

(6) $L_{i1940} = \alpha + \beta_1 D_c + \theta_1 X_{i1930} + \theta_2 X_{c1930} + \gamma_{s1930} + \gamma_a + \varepsilon_i$

There are two differences between Equation 5 and Equation 6. First, the primary explanatory variable in Equation 6 is an indicator variable of drought status by county (D_c). The indicator variable for drought status equals one if a county experienced three or more drought years (*drought counties*) and equals zero otherwise (*non-drought counties*). Second, Equation 6 uses only state fixed effects (γ_{s1930}) instead of state, county, or household fixed effects as in Equation 5. This is necessary because the variation of interest, drought status, is a county-level variable.

Table 21: Employment and wages for drought versus non-drought counties: non-migrants

	(1) Employed in 1940	(2) Employed in 1940	(3) Employed in 1940	(4) Log 1940 wage	(5) Log 1940 wage	(6) Log 1940 wage
Drought county	0.011**	0.009**	0.008**	0.065*	0.068***	0.057**
	(0.005)	(0.004)	(0.003)	(0.033)	(0.022)	(0.021)
Observations	1,653,696	1,653,696	1,653,696	849,941	849,941	849,941
R^2	0.079	0.12	0.11	0.073	0.35	0.36
Controls	No	Individual	Individual & county	No	Individual	Individual & county
Fixed effects	1930 state	1930 state	1930 state	1930 state	1930 state	1930 state

Standard errors clustered by 1930 state in parentheses

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

Notes: This table shows the results of regressing labor market outcomes (employment status and wage income) on drought status while restricting the sample to non-migrants. These results show that non-migrants who persisted in drought counties were doing well in April of 1940 compared to non-migrants who persisted in non-drought counties. These results use the linked sample of men (aged 20 to 60 in 1930). Results are weighted by the inverse probability of linkage. All regressions include age and state fixed effects. Individual and county controls are varied as discussed in the context of Equation 6 and in the text.

Table 21 displays the results of estimating Equation 6 for employment status (columns 1 through 3) and wage income (columns 4 through 6) restricting the sample to non-migrants. As in previous tables in this chapter, the inclusion of controls is varied between columns to show the stability of the estimated coefficients. By the most conservative estimates (columns 3 and 6) non-migrants from drought counties were 0.8 percentage points more likely to be employed and were making 5.7 log percentage points more on average than similar men in non-drought counties. These results are stable across specifications and show that individuals who started and remained in counties that experienced three or more drought years, were doing better in terms of employment and wages compared to similar individuals who started and stayed in non-drought counties within the same state.

The findings of Table 21, that men who persisted in drought counties, had better outcomes in 1940 compared to men who persisted in non-drought counties is counterintuitive given the negative consequences of drought documented in Chapter 5. Yet, it is important to interpret these results as a snapshot of outcomes in April of 1940 (the month of census enumeration) rather than a portrayal of labor market prosperity through the entire 1930s. Traditionally, the drought is considered to have ended in 1939, and possibly individuals who persisted in drought counties reaped the benefits of local labor markets that witnessed population declines during the 1930s. This explanation is further explored in the Discussion section.

Triple interaction model: drought, education, and migration

The preceding two sections estimate labor market outcomes for migrants and non-migrants from drought and non-drought counties in separate equations for ease of interpretation. Another way to estimate differential outcomes is in one triple interaction model as specified in Equation 7.

$$(7) \quad L_{i1940} = \alpha + \beta_1 M_i + \beta_2 E_i + \beta_3 D_c + \beta_4 (M_i \times D_c) + \beta_4 (M_i \times E_i) + \beta_6 (D_c \times E_i) + \beta_7 (M_i \times E_i \times D_c) + \theta_1 X_{i1930} + \theta_2 X_{c1930} + \gamma_{s1930} + \gamma_a + \varepsilon_i$$

Equation 7 has the same basic set up and controls as Equation 5 (and Equation 6) but includes additional interaction terms to study the differential impact of drought, migration, and education in one equation.

The omitted category are non-migrant men with less than an 8th grade education and from non-drought counties. The variable $(M_i \times D_c)$ is an indicator variable equal to one if individual *i* was a migrant who started in a drought county. The vector $(M_i \times E_i)$ includes two indicator variables. One indicator for whether individual *i* was a migrant with an 8th to 11th grade education and another for whether individual *i* was a migrant with greater than an 11th grade education. The vector $(D_c \times E_i)$ includes two indicator variables. One indicator for whether individual *i* was from a drought county and had an 8th to 11th grade education and another indicator variable for whether individual *i* was from a drought county and had greater than an 11th grade education. Finally, the vector $(M_i \times E_i \times D_c)$ contains two indicator variables. One indicator for whether individual *i* was a migrant with an 8th to 11th grade education and from a drought county, and another indicator variable for whether individual *i* was a migrant with greater than an 11th grade education and from a drought county.

Given these definitions, the coefficients for the non-interaction terms are interpreted as follows. The coefficient for the indicator variable of migrant status (M_i) is the estimated differences in a labor market outcome between migrants and non-migrants with less than an 8th grade education and from non-drought counties. The coefficients for the indicator variables in the vector (E_i) are the estimated differences in a labor market outcome for non-migrants in non-drought counties based on their education level. Finally, the coefficient for the indicator variable (D_c) is the estimated differences in a labor market outcome for non-migrants with less than an 8th grade education based on drought status in their county.

Table 22 displays the results of estimating Equation 7 using the linked sample of adult men with the outcome variables of employment status (column 1) and log 1940 wage income (column 2). Mostly, the results of Table 22 replicate and validate what was seen and discussed in previous tables: migrants with less than an 8th grade education and from both drought and non-drought counties were less likely to be employed and made roughly the same in wages compared to similar non-migrants. Migrants with more education did better in terms of employment and wages. Non-migrants who persisted in drought counties were doing well in 1940 compared to non-migrants from non-drought counties.

Table 22 also adds detail to two previous results. First, Table 22 shows that the relatively good labor market outcomes for non-migrants in drought counties was spread across the education distribution. That is, the coefficient for *drought county* is positive and significant, while the

Table 22: Employment and wages by drought, migration, and education

	(1) Employed in 1940	(2) Log 1940 wage
Migrant	-0.062***	-0.023
	(0.004)	(0.014)
8th to 11th education	0.044***	0.244***
	(0.004)	(0.016)
>11th education	0.069***	0.519***
	(0.005)	(0.022)
Drought county	0.017***	0.078***
	(0.006)	(0.024)
(Migrant)×(drought origin)	-0.007	-0.076***
	(0.004)	(0.018)
(Migrant)×(8th to 11th)	0.020***	0.055***
	(0.003)	(0.015)
(Migrant)×(> 11th)	0.034***	0.103***
	(0.004)	(0.016)
(8th to 11th)×(drought county)	-0.007	-0.028
	(0.005)	(0.019)
(> 11th)×(drought county)	-0.008	-0.037
	(0.006)	(0.026)
(Migrant)×(8th to 11th)×(drought origin)	0.002	0.018
	(0.004)	(0.017)
(Migrant)×(> 11th)×(drought origin)	0.009*	0.043*
	(0.005)	(0.022)
Observations	2,118,507	1,117,445
Controls	Yes	Yes
Fixed effects	1930 state	1930 state

Standard errors clustered by 1930 state in parentheses

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

Notes: This table displays the results regression labor market outcomes with a triple interaction model as specified in Equation 7. Largely, these results confirm the results of Tables 17, 18, and 20. These results use the linked sample of men (aged 20 to 60 in 1930). Results are weighted by the inverse probability of linkage. Regressions include age and 1930 state fixed effects. Individual and county controls are included as discussed in the context of Equation 5.

coefficients for the interaction terms of higher education and drought status are negative and insignificant. This indicates that non-migrants in drought counties were doing well overall, and prosperity was not any more concentrated to individuals with higher education than in other counties. Second, Table 22 expands on Table 19 by displaying the outcomes of drought and non-drought migrants heterogeneously by education level. This disaggregation shows that the gains from migration might have been higher for migrants with a higher school education or higher from drought counties compared to other well-educated migrants (and relative to similar non-migrants).[67]

Discussion

This chapter evaluates the labor market outcomes using linked samples of men. The primary result of this chapter is that there was heterogeneity in outcomes for migrants based on individual education attainment. Migrants aged 20 to 60 in 1930 with less than an 8th grade education were less likely to be employed and made less in wages compared to similar non-migrants from their origin county. As education attainment increased, the gap between employment status for migrants versus non-migrants decreased and highly educated migrants earned more in wages compared to non-migrants. This chapter also presents auxiliary results showing that drought and non-drought migrants had similar outcomes and that those men who remained in drought counties were doing well compared to non-migrants from non-drought counties in 1940. This section discusses these results in the context of previous research.

The finding that migrants with less than an 8th grade education were less likely to be employed than non-migrants is consistent with historical literature and popular narratives focused on migrants from the Dust Bowl (Lange 1969, Babb 2004, Worster 2004, Steinbeck 2006, Hornbeck 2020). As Worster (2004) writes "But those [migrants] who did get jobs were the

[67] The positive and significant coefficients for the triple interaction term *(migrant)×(>11th)×(drought origin)* should be considered in the context of the coefficients of *drought county* and *(migrant)×(drought county)*. The coefficients for *drought county* are positive and significant as discussed. The coefficients for *(migrant)×(drought county)* are negative, but do not indicate that migrants from drought counties were doing worse than other migrants because this coefficient is relative to the positive coefficients for *drought county.* Considering all three coefficients, those for the triple interaction term indicate that highly educated migrants from drought counties had higher returns to migration than other highly educated migrants.

fortunate ones; much worse off were the thousands forced to squat by the side of the road, having no prospects of work at all." I expand on this statement by showing that the labor market difficulties of migrants were concentrated to migrants with little formal education. Migrants with higher education did significantly better.

My results on the heterogeneity of outcomes based on education are novel for environmental migrants but are broadly consistent with research on migration during the Great Depression. Sons from more affluent families made better migration decisions and thereby mitigated some economic repercussions of the Depression (Feigenbaum 2015). Additionally, I show that migrants from drought and non-drought origins faced similar prospects. This finding is intriguing in light of previous literature stressing the prejudice face by migrants believed to have originated from the Dust Bowl (Hurt 1984, Worster 2004). More generally, this finding is interesting in the context of climate migrants who might differ from other migrants on a number of dimensions. At least in terms of employment status and wages, migrants from the drought region were not definitively worse off than other migrants.

This chapter also documents that non-migrants in drought counties were faring comparatively well in 1940. This finding suggests potential opportunities for those who persist through temporary environment shocks and that impacted regions may recover quickly once the shock subsides. As Riney-Kenhrberg (1994) writes: "By 1940, the crisis was largely over. Although people were cautious about their prospects, the potential for recovery was more real than it had been in a decade. In that year, many farmers harvested their first paying crop since 1930." Nonetheless, it is important to consider the nature of the environmental shock when discussing the economic recovery. When the drought diminished in 1940, the continuing damage of drought likely also dwindled as crops and economic prosperity returned to the region. By contrast, the economy is not so pliable in relation to other environmental shocks, such as soil erosion, for which the negative consequences may last decades after the conditions contributing to erosion have been corrected (Hornbeck 2012). Furthermore, there was substantial investment in improving farming practices by both Federal Government initiatives related to AAA spending and local movements that likely aided a robust recovery for the drought region.

CHAPTER 8

CONCLUSION

Adaptation to environmental disasters is vital to human survival and progress. Considering the importance of environmental adaptation and relative to 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 drought was a long and widespread shock that impacted an ecologically and economically diverse country. These characteristics, combined with the demographic and economic information afforded by the 1930 and 1940 censuses, allow for the study of migration, including how many people move, who moved, where migrants went, and how migrants fared at their destinations. The findings of this dissertation contribute to a detailed understanding of migration as an adaptation method to environmental shocks, and the repercussion of environmental migration for migrants and the economy as a whole.

To conclude, I briefly restate the main finding from each chapter on the economic responses to drought (Chapters 5, 6, and 7). Then, I discuss each finding's implications. First, in Chapter 5, I find that the drought impacted migration patterns. But that these impacts did not become apparent until the mid-1930s when the drought settled and persisted on the Great Plains. Second, in Chapter 6, I find that highly educated individuals, those with a high school education or higher, were most inclined to move from drought. Finally, in Chapter 7, I find that migrants were less likely to be employed and had wages (when they were employed) comparable to similar non-migrants. As with the decision and ability to migrate, there was heterogeneity in how well migrants did based on their education. High unemployment and low wages were concentrated among migrants with less than an 8th grade education, while highly educated migrants were more likely to be employed than less educated migrants and made more in wages compared to similarly educated non-migrants.

On the whole, this dissertation studies migration from drought in a complete and detailed manner: from the beginning of the drought, to individual migrant characteristics and destinations, to the end of the drought and economic outcomes. I show that drought impacted population and human capital distributions in a way that resonates to this day, as the Great Plains remain sparsely populated. The exceptional drought, in connection with excellent data records, provides a unique opportunity to study the consequences of a climate shock by individual characteristics. Therefore, the 1930s drought is among the most informative episodes concerning mass climate migration in human history. The specific contributions of each chapter are discussed in the following paragraphs.

In the sphere of research on the relationship between the environment and the economy, economic adaptation to environmental shocks (including climate change) has received much less attention than policies for mitigating environmental pollutants (Libecap and Steckel 2011). The comparative lack of research on environmental adaptation is a problem because, regardless of anthropogenic climate change, severe weather and climate events will always impact humans. Moreover, in the context of climate change, and the sheer number of people on earth today, questions concerning extreme weather and climate fluctuations are more pressing than ever (Strzepek et al. 2010, Cook et al. 2018). Understanding the intricacies of adaptation is of tantamount importance to future economic stability and sustainability.

Migration potentially enables humans to mitigate the damage of climate shocks. As such, previous research documents relationships between migration and climate deviations (Graves

1980, Brown 2008, Piguet et al. 2011). Chapter 5 of this dissertation adds to previous research by showing a robust statistical relationship between migration and drought in the 1930s. Still, much of modern microeconomics is centered on moving past statistical correlations to estimate causal impacts. In fact, often environmental shocks such as drought, and variations in rainfall and heat, are used as exogenous variation to isolate the causal impact of other variables.[68] The detailed study of the impact of drought highlights that questions of whether, and to what extent, environmental shocks are exogenous are difficult questions that require careful consideration of the underlying climate, and how the climate impacted variables leading up to the shock of interest.

Chapter 5 uses county-level variation in drought intensity to estimate how additional drought years were related to migration while controlling for extensive county-level covariates and state fixed effects. That is, Chapter 5 uses detailed microdata and modern econometrics to isolate the impact of drought to the greatest extent possible. Still, these estimates should be considered in the context of a region defined by persistent variations in precipitation and heat. The Great Plains are a drought prone and semi-arid environment as described in Chapter 2. These climate conditions led to the late European-American settlement of the Plains. Moreover, these conditions led to a demographically distinct region in 1930 as described in Chapter 4. This is to say, the depopulation of the Great Plains that resulted from drought was one dramatic episode in the boom-and-bust cycle of a climatically volatile region. The underlying climate and history of the region is central to the story of drought and migration during the 1930s. Generally, the history, demographics, and economic circumstances of specific locations are deeply connected to the environmental conditions of that area and the casual impact of shocks must be considered in this context.

[68] That is, weather and climate deviations are often used as instrumental variables. See Miguel et al. (2004) for a prominent example or Rosenzweig and Wolpin (2000) for a review of literature.

Additionally, in terms of contributions of Chapter 5, little previous research closely studies the timing of migration from persistent climate shocks. Understanding the timing of migration is key because responses to environmental shocks vary widely and the temporal length of shocks might be a central factor. Chapter 5 shows that 1934 was a definitive drought year and that the mass migration from drought started in and continued after 1934. In the 1930s, it took an exceptionally bad drought year (centered on a semi-arid and recently settled region) to spur migration. But after 1934, as drought persisted on the Plains, additional drought years also led to higher migration out of and away from drought. This finding on the timing of migration is important in the context of persistent climate change, such as we are experiencing today, and in the context of repeated shocks such as drought and its associated maladies.

In the 1930s, drought contributed to the size and frequency of dust storms on the Great Plains. Today, drought contributes to the size and frequency of wildfires across the western United States. What year in the 21st century will mirror 1934 as a tipping point, after which people move *en masse* rather than face another year of drought and wildfire? When this migration occurs, the foremost questions will be: what fraction of the population will move, who will move, where will people go, and what job opportunities will they have? The 1930s is the most direct historic corollary concerning mass environmental migration in the United States. Chapter 5 answers the first of these questions. Chapters 6 and 7 answer the last three, and while some previous research addresses how environmental shocks impact aggregate migration, much less research is able to describe exactly who moves, where they go, and how they fair.

Chapter 6 shows that the primary migration response to drought occurred among highly educated individuals. This finding expands our understanding of migration from environmental shocks by identifying specific segments of the population that moved. The large migration triggered by drought conditions has been recognized since the time of its occurrence (at least for the Dust Bowl portion of the drought region) (Taylor and Vaset 1936, Hoffman 1938). Only recently have researchers started to answer questions concerning the composition of migrants (Long and Siu 2018, Hornbeck 2020). This previous focus on aggregate migration, versus analyzing who specifically moved during the 1930s, mirrors the state of research on environmental migration broadly.

How climate shocks differentially impact migration decisions, based on individual characteristics, is important to understanding who bears the costs of climate shocks, the lasting implications of shocks, and evaluating the gains of migration. This dissertation is the first research, to my knowledge, to estimate how a climate shock differentially impacted individual migration propensities by human capital. The result that highly educated individuals increased their migration rates, while less educated individuals did not, shows that migration is an adaptation method that might only be adopted by relatively affluent people. Even so, it is important to contextualize exactly what is being estimated. In Chapter 6, I estimate the impact of county-level variation in drought years on individual migration propensities compared to similar individuals within the same state but in counties with less drought. The wider impacts of drought, on the drought region as a whole, are not captured by these estimates. That is, it is possible (and likely given the descriptive statistics in chapters 4 and 6) that drought impacted the migration propensities of less educated people in the drought region as a whole while local variation in drought mattered less.

Lastly, Chapter 7 shows that migrants from drought and non-drought counties struggled to find gainful employment at their destinations. These difficulties were concentrated among migrants with little education. This finding contributes to our understanding of the returns to environmental migration. Previous research and popular accounts concerning the 1930s (focused on migration from the Dust Bowl) stress the hardships faced by migrants at their destinations.[69] No previous research studies the economic outcomes of migrants from the broader drought and no previous research stratifies migrant outcomes by individual education.

My findings are consistent with an extensive literature on the returns to migration (outside of the context of climate shocks) based on individual skill (Sjaastad 1962, Borjas 1992). But my findings are novel to literature on environmental migration, which largely has not studied the economic outcomes of migrants or heterogeneity in returns to migration with respect to skill. The findings of this dissertation on migrant outcomes highlight the riskiness of migration as an adjustment mechanism to climate shocks and underscore the importance of individual attributes in determining migrant success.

In conclusion, this research contributes to knowledge on the interaction of humans, the economy, and the environment. Much of the existing research centers on how humans impact the environment. But there is growing interest in how the environment influences economic activity, and adaptation methods to changing climate conditions are vital to the overall impact of environmental degradation. Migration is a fundamental adaptation method for humans and for all living organisms. The study of migration from large climate deviations elucidates the mechanisms through which people and the economy adapt, shows the resilience of people to catastrophic conditions, and highlights potential market shortcomings and vulnerabilities.

[69] See Lange and Cox (1987), Babb (2004), Worster (2004), Steinbeck (2006), Burns et al. (2012), and Hornbeck (2020)

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APPENDIX

Census linkage weighting

Linked samples between censuses are typically not representative of the demographics of the full count census. Therefore, it is common practice to estimate a probability model for how likely each individual is to be linked, and weight the linked sample by the inverse probability of being linked. This procedure has the effect of making the linked sample as close to possible to the demographic composition of the full count census.

Equation A1 is the probability model that I use to estimate how likely each individual was to be linked.

(A1) $L_i = \alpha + \beta_1 A_{i1930} + \beta_2 O_{i1930} + \beta_3 E_{i1940} + \theta_1 X_{i1930} + \varepsilon_i$

The outcome variable (L_i) is an indicator variable equal to one if individual *i* was linked between the 1930 and 1940. Linkage status is regressed on a vector on indicator variables for individual *i*'s age (A_{i1930}), a vector of indicator variables for occupation score in 1930 (O_{i1930}), a vector of indicator variables for education in 1940 (E_{i1940}), and a vector of indicator variables for individual characteristics: whether they were white, a home owner, married, lived in a city, employed, their income wage in 1940, lived on a farm, and were a house hold head.

Using the results of Equation A1, I estimate the likelihood that each man aged (20 to 60) in the 1930 census was linked between census based on their characteristics. I weight linked observations by the inverse of the probability that they were linked for all tables and analysis in Chapters 4, 5, and 7. This process weights the linked sample so that it is representative of the full count census as displayed in Table 1. This technique and the calculations are equivalent to those used and recommended by Abramitzky et al. (2020) for their published linked sample.

Alternate drought measure

I use the number of moderate or worse drought years for the primary independent variable in this paper. The number of drought years is a simple and straightforward measure of exposure to drought over multi-year time periods. Yet there are other ways to measure drought intensity over multi-year time horizons. Another measure of drought intensity is to sum the total index value of drought each county experienced over five- and ten-years periods. The number of drought years was ultimately chosen as the most intuitive way to measure drought over multiple years and the primary independent variation in this paper because it corresponds directly with the more commonly used and defined measures of drought intensity at the yearly level, whereas total drought relies on somewhat arbitrary cutoffs for the thresholds of *mild*, *moderate*, and *severe drought* over multiple years. The results of this paper are similar (and mostly larger and more significant) when using *total drought* instead of *number of drought years.*

To show that the main results of this paper are robust to an alternate measure of drought, Equation A2 defines a measure of total drought over five-year periods.

(A2) $Total\ Drought_c = -(\sum_{y=0}^{5} Drought\ Severity_{cy}\ | Drought\ Severity_{cy} < 0)$

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

(A3) $Normal\ Conditions_c = 1\ if\ Total\ Drought_c < 5$

$Mild\ Drought_c = 1\ if\ 5 <= Total\ Drought_c < 8$

$Moderate\ Drought_c = 1\ if\ 8 <= Total\ Drought_c < 11$

$Severe\ Drought_c = 1\ if\ 11 <= Total\ Drought_c$

Table A1: County-level migration from drought 1930 to 1935: alternate drought measure

	(1) Net migration	(2) Out-migration	(3) In-migration
Moderate drought	-0.010	-0.004	-0.015*
	(0.009)	(0.004)	(0.009)
Severe drought	-0.020	-0.001	-0.021*
	(0.013)	(0.008)	(0.011)
Observations	3,073	3,073	3,073

Standard errors clustered by 1930 state in parentheses

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

Notes: This table displays the results of regressing county-level migration measures against drought severity for the first half of the decade as a robustness check on the measure of multi-year drought exposure. As in the body of the paper, there was little relationship between drought years and migration in the first half of the decade. But there was a stronger relationship between in-migration and drought severity in the early 1930s using the alternate measure of drought. This indicates that drought in the early 1930s (and specifically the intensity of yearly drought beyond moderate) might have impacted destination choices to a greater extent than the primary specifications of the paper estimates. These regressions use the linked sample of adult men (aged 20 to 60 in 1930). Regressions include state fixed effects and county-level controls as detailed in Equation 1.

Normal Conditions are defined as having an average yearly drought index of less than one for the five-year time period. Referring to Table 1, yearly index values of less than 1 are classified as *near normal* or *incipient dry spell*. Each subsequent drought category is defined by adding a standard deviation in average drought severity over the five-year period.

I use this alternate definition of drought in estimating the main migration results over five-year periods for Chapter 5 and for the first table of selection results in Chapter 6. Tables A1 and A2 report the results of estimating Equation 2 with the total drought measure instead of drought years and correspond to Tables 7 and 9 from Chapter 5. The results are similar but there are two notable differences. First, *total drought* severity in the early 1930s is correlation with declines in in-migration in Table A1. This result is consistent with the results and discussion concerning the importance of 1934 as the regressions with total drought as the main independent variable put more weight on the severity of drought in single years. Second, the migration response out of drought

Table A2: County-level migration from drought 1935 to 1940: alternate drought measure

	(1) Net migration	(2) Out-migration	(3) In-migration
Moderate drought	-0.018	0.004	-0.015
	(0.017)	(0.008)	(0.013)
Severe drought	-0.067^{**}	0.029^{**}	-0.031^{*}
	(0.025)	(0.012)	(0.016)
Observations	3,073	3,073	3,073

Standard errors clustered by 1935 state in parentheses

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

Notes: This table displays the results of regressing county-level migration measures against drought severity for the second half of the decade as a robustness check on the measure of multi-year drought exposure. These results are similar (and stronger than the results reported in Table 9) indicating that severe or worse drought years had an added impact on migration beyond the impact of only a moderate drought year. These regressions use the linked sample of adult men (aged 20 to 60 in 1930). Regressions include state fixed effects and county-level controls as detailed in Equation 1.

counties is more pronounced in the late 1930s when using total drought. This indicates that drought beyond moderate drought at the yearly level had additional impacts on migration as is expected.

Table A3 displays the results of estimating Equation 3 from Chapter 6 using the alternate measure of drought intensity to show that the main results of Chapter 6 are also robust to the alternate drought measure. The results in Table A3 are similar to the results from Table 12. The main difference between the results on selection is that with the total drought severity variable (presented in the appendix) there is stronger migration away from drought conditions among people with less than an 8th grade education from farm and city origin locations (columns 5 and 6 in Table A3). This difference in results suggests that the migration patterns of people with lower human capital might be more responsive to severe one-time shocks as the total drought severity variables put more weight on severe drought years, whereas the number of drought years variables treats all years with moderate or worse drought as the same.

Table A3: Migration response to drought severity by education attainment: alternate drought measure

	(1) Migrant	(2) Migrant	(3) Migrant	(4) Migrant	(5) Migrant	(6) Migrant
8th to 11th grade ed.	0.011***	0.012***	0.010***	0.038***	0.006**	0.008***
	(0.002)	(0.002)	(0.002)	(0.005)	(0.003)	(0.002)
> 11th grade ed.	0.061***	0.058***	0.065***	0.125***	0.028***	0.058***
	(0.003)	(0.003)	(0.004)	(0.006)	(0.004)	(0.005)
Moderate	-0.010	-0.014**	-0.007	-0.031*	0.007	0.033*
	(0.007)	(0.007)	(0.008)	(0.017)	(0.010)	(0.017)
Severe	-0.001	-0.006	0.002	-0.035	0.023	0.078***
	(0.008)	(0.006)	(0.009)	(0.026)	(0.015)	(0.022)
(Moderate)×(8th to 11th)	0.013**	0.017***	0.011*	0.026**	0.006	0.012
	(0.006)	(0.005)	(0.006)	(0.013)	(0.008)	(0.009)
(Severe)×(8th to 11th)	0.022***	0.026***	0.018***	0.046***	0.018***	0.015***
	(0.004)	(0.004)	(0.004)	(0.013)	(0.006)	(0.005)
(Moderate)×(> 11th)	0.048***	0.051***	0.047***	0.059***	0.026**	0.041**
	(0.009)	(0.009)	(0.010)	(0.017)	(0.013)	(0.019)
(Severe)×(> 11th)	0.071***	0.074***	0.070***	0.086***	0.047***	0.053***
	(0.009)	(0.008)	(0.011)	(0.015)	(0.011)	(0.011)
Observations	55,326,741	27,387,808	27,938,933	7,823,756	7,187,616	25,585,743
Sample	Adults	Women	Men	Non-city non-farm origin	Farm origin	City origin

Standard errors clustered by 1935 state in parentheses

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

Notes: These results recreate the primary results of Chapter 6 using an alternate measure of drought severity from 1935 to 1939. The results are similar to the results presented in the main texts of the paper. Differences between these results and the main specification are discussed in the Appendix. Sample includes adults (25 to 65 in 1935) from the full count 1940 census. Regressions include age and state fixed effects, and individual and county-level controls as detailed in Equation 3.

Alternate census linking criteria

The linked data set from the 1930 to 1940 census used in this paper (described in Chapter 3) is based off very strict linking criteria. Such strict linking criteria was chosen for the main linked sample to minimize the number of and bias from false linkages. The risk with such strict linking criteria is that results might be driven by heightened selection into linkage. This possibility is mitigated by the fact that all results in this paper that use the linked sample are weighted by the inverse probability of linkage. Nonetheless, Tables A4 and A5 show main results of Chapter 5 and 7 with a sample linked on less strict criteria.

The data underlying Tables A4 and A5 are a linked sample from Abramitzky et al. (2020). The data in this sample are linked by both of the two most conservative linking algorithms but without the additional linking criteria that I impose in Chapter 3 (links do not have to report the exact same age (plus ten years) in the 1940 census). This increases the number of observations in the linked sample from 2.6 million (used in the main text) to 4.2 million men aged 20 to 60 in 1930. The results in both Table A4 and A5 are similar to the results in the main text of this paper (Table 6 and column 4 of Tables 16 and 17) indicating that the results of this paper that rely on the linked data set are robust to alternate linking criteria.[70]

[70] The results in A4 recreate Table 6, and the results in A5 recreate column 4 of Tables 16 and 17.

Table A4: County-level migration from drought 1930 to 1940: alternate census linkage

	(1) Net migration	(2) Out-migration	(3) In-migration
3 drought years (1930 to 1939)	-0.025*	0.009*	-0.016
	(0.012)	(0.005)	(0.012)
4 drought years (1930 to 1939)	-0.022	0.016**	-0.006
	(0.015)	(0.007)	(0.016)
5+ drought years (1930 to 1939)	-0.018	0.017**	-0.001
	(0.018)	(0.008)	(0.016)
Observations	3,073	3,073	3,073

Standard errors clustered by 1930 state in parentheses

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

Notes: This table displays the results of regressing county-level migration measures against drought severity for the entire decade using alternate census linkage criteria. These results are similar to the results in Table 6 indicating that the main results of Chapter 5 are robust to alternate linkage criteria. These regressions use the alternate linked sample of adult men (aged 20 to 60 in 1930) describe in the Appendix. Regressions include state fixed effects and county-level controls as detailed in Equation 1.

Table A5: Employment and wages by migrant status and education (drought origins): alternate census linkage

	(1) Employed in 1940	(2) Log 1940 wage
Migrant	-0.075***	-0.082***
	(0.002)	(0.024)
(Migrant)×(8th to 11th)	0.016***	0.086***
	(0.002)	(0.012)
(Migrant)×(> 11th)	0.042***	0.164***
	(0.002)	(0.017)
Observations	1,866,345	941,906
R^2	0.11	0.37
Controls	Yes	Yes
Fixed effects	1930 county	1930 county

Standard errors clustered by 1930 state in parentheses

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

Notes: This table shows the results of regressing labor market outcomes (employment status and wage income in 1940) on migrant status interacted with education compared to non-migrant at the origin county using a census link with less strict linkage criteria. These results are directly comparable to column 4 of Tables 16 and 17. In both cases, the results from estimating the regressions with the alternate sample produce results very similar to the results in the main body of the paper. These regressions use the alternate linked sample of adult men (aged 20 to 60 in 1930) describe in the appendix. Results are weighted by the inverse probability of linkage. Regressions include age and 1930 county fixed effects. Individual controls are included as discussed in the context of Equation 5.

Measures of selection

Equation 3 of this paper estimates whether drought increased individuals' propensities to migrate while distinguishing by education attainment. Positive coefficients from the interaction terms indicate that more highly educated individuals were more inclined to migrate away from drought counties. That is, Equation 3 estimates whether drought induced more migration for highly educated people.

There are other ways to measure selection into migration. In particular, a measure along the lines of Equation A4 is used in related papers.

(A4) $E_i = \beta_1 M_i + \beta_2 D_c + \beta_3 (D_c \times M_i) + \gamma_{s1935} + \gamma_a + \theta_1 X_{i1935} + \theta_2 X_{c1935} + \varepsilon_i$

The difference between Equation 3 of Chapter 6 and Equation A4 is that *education attainment* is the outcome variable in Equation A4 whereas *education* is an independent variable in Equation 3. Correspondingly, *migrant* is an independent variable in A4 whereas *migrant* is the outcome variable in Equation 3. Moreover, in Equation A4, the outcome *education* is an integer for the number of years of school individual *i* completed rather than a series of categorical variables as in Equation 3. The rest of Equation A4 is the same as Equation 3 as described in the Empirical Framework section of Chapter 6.

The main coefficient of interest in Equation A4 is β_3. The coefficient β_3 estimates whether migrants from drought counties had relatively higher or lower education compared to migrants from non-drought counties. That is, β_3 is a measure of the average education for a migrant from a drought county relative to the average education of a migrant from a non-drought county. This estimates whether migrants were positively or negatively selected on average.

The results of estimating Equation A4 are reported in Table A6. They show that the average migrant from drought counties was not any more positively or negatively than the typical migrant

Table A6: Average education for migrants by drought exposure

	(1) Highest grade	(2) Highest grade	(3) Highest grade	(4) Highest grade
Migrant	0.740***	0.745***	0.674***	0.683***
	(0.055)	(0.055)	(0.063)	(0.063)
2 drought years	-0.018		-0.043	
	(0.023)		(0.028)	
3+ drought years	-0.005		-0.020	
	(0.017)		(0.018)	
(Migrant)×(2 drought years)	-0.005	-0.004	0.122	0.118
	(0.112)	(0.113)	(0.116)	(0.115)
(Migrant)×(3+ drought years)	0.002	0.007	0.080	0.080
	(0.083)	(0.083)	(0.062)	(0.063)
Observations	55,302,121	55,302,121	10,186,158	10,186,158
Fixed effects	1935 state	1935 county	1935 state	1935 county
Sample	U.S.	U.S.	Great plains	Great plains

Standard errors clustered by 1935 state in parentheses

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

Notes: This table estimates whether the average migrant from drought counties was more or less positively selected than migrants from non-drought counties. Columns 3 and 4 restrict the sample to counties on the Great Plains for comparison to erosion as estimated in Table A7 and Hornbeck (2020). Sample includes adults migrants (25 to 65 in 1935) from the full count 1940 census. Age and state fixed effects, and individual and county controls are included as discussed in the Empirical Framework and *Measures of Selection* Appendix sections.

in the late 1930s (who was positively selected). These results do not contradict the main results of this paper. Whether the average migrant from drought counties was positively selected depends on the impact of drought on selection, the relative distribution of education, and the migration rates for education levels at the county level. The drought region was comparatively well educated following the high school movement of the early 20th century (Goldin and Katz 1999) and likely had underlying characteristics that made individuals more likely to migrate compared to other parts of the U.S. as discussed in Chapter 4. Therefore, my results that drought induced more positive selection at the individual level in Chapter 6 do not imply that migrants from drought counties were more positively selected on average.

For comparison to Hornbeck (2020) in estimating whether drought and soil erosion on the Great Plain were associated with the average migrant being more or less positively selected,

Table A7: Average education for migrants by soil erosion

	(1) Highest grade	(2) Highest grade	(3) Highest grade	(4) Highest grade
Migrant	0.721***	0.724***	0.731***	0.741***
	(0.046)	(0.046)	(0.079)	(0.079)
Moderate erosion	-0.009		-0.002	
	(0.007)		(0.008)	
Severe erosion	0.006		-0.003	
	(0.006)		(0.006)	
(Migrant)×(moderate erosion)	0.195	0.224	-0.112	-0.125
	(0.161)	(0.169)	(0.076)	(0.093)
(Migrant)×(severe erosion)	-0.023	-0.020	-0.324***	-0.429***
	(0.076)	(0.088)	(0.081)	(0.130)
Observations	55,302,121	55,302,121	10,186,158	10,186,158
Fixed effects	1935 state	1935 county	1935 state	1935 county
Sample	U.S.	U.S.	Great plains	Great plains

Standard errors clustered by 1935 state in parentheses

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

Notes: Sample includes working age migrants (22 to 65 in 1935). This table estimates the impact of soil erosion as studied in Hornbeck (2020). Sample includes adult migrants (25 to 65 in 1935) from the full count 1940 census. Age and fixed effects, and individual and county controls are included as discussed in the Empirical Framework and *Measures of Selection* Appendix sections.

columns 3 and 4 of Table A6 restrict the sample to the Great Plains. Table A7 estimates Equation A4 by erosion severity at the county level as defined in Hornbeck (2020). When restricting the sample to the Great Plains, the average migrant from counties with three or more drought years was more positively selected than migrants from non-drought counties as shown in columns 3 and 4 of Table A6 but these results are not statistically significant. The opposite was true for erosion as shown in columns 3 and 4 of Table A7. Severe erosion was associated with the average migrant from the Great Plains being more negatively selected as shown in Hornbeck 2020.[71]

[71] Columns 1 and 2 of A7 estimate whether the average migrant was selected based on erosion severity across the U.S. as a whole. The results of columns 1 and 2 show that migrants from more eroded counties were not more positively selected for the U.S. as a whole as they were on the Great Plains as seen in columns 3 and 4. This indicates that erosion had a differential impact on selection into migration depending on the geographic region and is an area for future inquiry.

There are a number of possible reasons why erosion led the average migrant from eroded counties on the Plains to have been more negatively selected while having little impact on the average drought migrant. First, from a technical perspective, drought and soil erosion were different shocks and impacted different areas. The worst drought on the Great Plains was west and north of the worst soil erosion. Second, the drought ebbed and flowed throughout the 1930s, but when the heat subsided and rains returned, agriculture and other aspects of life may have returned to their pre-drought status relatively quickly. The same was not true for counties with severe erosion as erosion was more permanent damage. That is, possibly the persistence of erosion damage helps explain the difference in the selection response to drought versus soil erosion.

This section presents the basics of the difference between measuring how drought impacted selection into migration for individuals versus measuring whether the average migrant from drought counties was positively selected. Moreover, this section presents some differences in the migration response to drought versus erosion. Both of these topics are areas for further investigation.

Triple interaction model: drought, education, and Depression severity

Figure 19 of Chapter 6 reports the results of estimating changes in migration propensity in response to drought by Depression severity at origin counties. The regressions underlying Figure 19 are based on Equation 3 with the sample differentiated by Depression severity. That is, for Figure 19, I estimate Equation 3 for the sample of counties that suffered severe Depression conditions or not separately. This method is straightforward and the results are relatively easy to interpret. The results of this estimation, reported in Figure 19, indicate that there was more positive selection into migration in counties that suffered more severe economic down turns during the Great Depression. This result is consistent with the hypothesis that individual liquidity constrained migration decisions. But the results of Figure 19 do not formally examine the statistical differences in selection between counties by Depression severity.

Equation A5 is a triple interaction model that estimates the same relationship as is displayed in Figure 19 but enables the direct examination of the statistical significance of differences.

$$\text{(A5)}\ M_i = \alpha + \beta_1 E_i + \beta_2 D_c + \beta_3 S_c + \beta_3 (D_c \times E_i) + \beta_3 (S_c \times E_i) + \beta_3 (D_c \times S_c) + \beta_3 (D_c \times E_i \times S_c) + \theta_1 X_{i1935} + \theta_2 X_{c1935} + \gamma_{s1935} + \gamma_a + \varepsilon_i$$

Equation A5 has the same basic structure and controls as Equation 3 in Chapter 6 but includes additional interaction terms to study the differential impact of drought, education, and Depression severity in one equation. The omitted category are individuals with less than an 8th grade education who started in non-drought counties that did not have severe Depression conditions.[72] The vector $(S_c \times E_i)$ includes two indicator variables: one indicator variable for whether individual i had an 8th to 11th grade education and was from a county with severe

[72] Counties with severe Depression are those that suffered worse than average declines in retail spending from 1929 to 1935.

Table A8: Selection: migration from drought by education and depression severity

	(1) Migrant
8th to 11th grade education	0.011***
	(0.002)
$>$ 11th grade education	0.058***
	(0.002)
2 drought years	0.001
	(0.006)
3+ drought years	-0.002
	(0.007)
Severe Depression	-0.007***
	(0.003)
(2 drought years)×(8th to 11th)	0.002
	(0.005)
(3+ drought years)×(8th to 11th)	0.012***
	(0.004)
(2 drought years)×($>$ 11th)	0.019**
	(0.008)
(3+ drought years)×($>$ 11th)	0.044***
	(0.007)
(8th to 11th)×(severe Depression)	-0.001
	(0.003)
($>$ 11th)×(severe Depression)	-0.005
	(0.004)
(2 drought years)×(severe Depression)	-0.001
	(0.011)
(3+ drought years)×(severe Depression)	-0.004
	(0.006)
(2 drought years)×(8th to 11th)×(severe Depression)	0.016
	(0.012)
(3+ drought years)×(8th to 11th)×(severe Depression)	0.008
	(0.006)
(2 drought years)×($>$ 11th)×(severe Depression)	0.021
	(0.015)
(3+ drought years)×($>$ 11th)×(severe Depression)	0.020**
	(0.009)
Observations	50,025,861

Standard errors clustered by 1935 state in parentheses

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

Notes: This table present the results of a triple interaction regression corresponding to the results from Figure 19. Figure 19 is based on restricting the sample to high and low Depression counties whereas the regression for this table estimates the relationship with interaction terms. Individuals from counties with *severe depression* are those from counties that suffered worse than average declines in retail spending from 1929 to 1935. Sample includes adults (25 to 65 in 1935) in the full count 1940 census. Regression includes age and state fixed effects, and individual and county controls as discussed in the context of Equation 3

Depression, and another indicator for whether individual i had greater than an 11th grade education and was from a county with severe Depression. The vector $(D_c \times S_c)$ includes two indicator variables: one indicator variable for whether individual i was from a county with two years of drought and severe Depression, and another indicator for whether individual i was from a county with three or more years of drought and severe Depression. Finally, the triple interaction vector $(D_c \times E_i \times S_c)$ contains four indicator variables that are the combination of drought status, education level, and Depression severity.

The results of estimating Equation A5 are reported in Table A8. The results are consistent with the results displayed in Figure 19 indicating that positive selection into migration from drought was even more attenuated in counties with severe economic downturns. The final coefficient in Table A8 is positive and significant, showing that highly educated men from drought counties moved 2 percent more than similar men from non-drought counties.

Occupational income scores outcomes

Chapter 7 uses wage income in 1940 to evaluate how well migrants were doing compared to non-migrants. The 1940 census was the first to record wage income and the variable includes wage income only for individual that “worked for wages”. That is, the wage income variable does not include income for self-employed individuals, such as farmers. An alternative measure of income included in the IPUMS 1940 census data is *occupational income score*. Occupational income scores are a measure of occupational standing (or income) based on occupation. Occupation scores are commonly used in economic history research before wages were commonly recorded. To check the robustness of the wage income results in Chapter 7, I rerun the analysis with the alternate outcome variable of log occupational income score.

The results are reported in Table A9 and are similar to the results using wage income in Table 18 of Chapter 7. Both Table A9 and Table 18 tell the same basic story: migrants (adults aged 20 to 60 in 1930) with little education had lower wages (or occupational standing) compared to similar non-migrants. But as education increased, so did wages and occupational standing, so that migrants with a high school education or higher were making more in 1940 compared to similar non-migrants. As in Table 18, the results are different when considering the economic outcomes for younger men. For young men, migrants had higher wages and occupational standing regardless of education. When estimating this relationship with occupational income score, there were some larger gains for better educated young men but those differences are mostly not statistically significant. Taken together, Table A9 shows that the results of Table 18 are robust to measuring wages or occupational standing with either wage income or occupational income score.

Table A9: Occupational income scores by migrant status and education: drought origins

	(1) Log 1940 occ. score	(2) Log 1940 occ. score	(3) Log 1940 occ. score	(4) Log 1940 occ. score	(5) Log 1940 occ. score	(6) Log 1940 occ. score
Panel A: non-interaction models						
Migrant	-0.020	0.003	0.004	0.006	0.155***	0.150***
	(0.013)	(0.006)	(0.006)	(0.006)	(0.014)	(0.012)
Panel B: interaction models						
Migrant	-0.060***	-0.026***	-0.025***	-0.025***	0.122***	0.076*
	(0.018)	(0.007)	(0.007)	(0.007)	(0.041)	(0.040)
(Migrant)×(8th to 11th)	0.053***	0.034***	0.034***	0.035***	0.021	0.071
	(0.007)	(0.003)	(0.003)	(0.003)	(0.040)	(0.043)
(Migrant)×($>$ 11th)	0.060***	0.053***	0.054***	0.056***	0.055	0.095**
	(0.013)	(0.004)	(0.004)	(0.004)	(0.039)	(0.039)
Observations	1,043,574	1,043,574	1,043,574	1,043,458	25,986	25,904
R^2	0.10	0.48	0.48	0.48	0.37	0.74
Controls	No	Yes	Yes	Yes	Yes	Yes
Geographic fixed effects	No	No	1930 state	1930 county	1930 county	Household
Sample	Full linked	Full linked	Full linked	Full linked	Brothers age 14 to 18	Brothers age 14 to 18
Implied coefficient bound ($\tilde{R} = 1.3 \times \hat{R}$) for Panel B						
Migrant				-0.011		
(Migrant)×(8th to 11th)				0.028		
(Migrant)×($>$ 11th)				0.055		

Standard errors clustered by 1930 state in parentheses

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

Notes: This table shows the results of regressing log occupational income score on migrant status interacted with education for the sample of men who started in drought counties (counties that subsequently experienced three or more drought years). This table corresponds to Table 18 in the main text. Occupational income scores are a measure related to wages and are often used in historical research before wages were widely recorded. The results using occupational income scores look similar to the results using wages as discussed more in the text of the Appendix. The results in columns 1 through 4 use the linked sample of men (aged 20 to 60 in 1930). The results of columns 5 and 6 use the linked sample of young men (14 to 18 in 1930) to address the potential for OVB. Results are weighted by the inverse probability of linkage. All regressions include age fixed effects. Geographic fixed effects and controls are varied as discussed in the context of Equation 5 and in the text.