Dust Bowl Migrants: Environmental Refugees and Economic Adaptation *

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Abstract

The 1930's American Dust Bowl created archetypal "Dust Bowl migrants," refugees from environmental collapse. I examine this archetype, comparing migration from more-eroded and less-eroded counties to distinguish Dust Bowl migrants from other migrants. Dust Bowl migrants were "negatively selected," in years of education, compared to other migrants who were "positively selected." Dust Bowl migrants had lower incomes than natives in their destinations, which is reflected in popular impressions. I estimate strikingly modest impacts of the Dust Bowl on average wage incomes in 1939, however, which contrasts with the Dust Bowl's large and enduring impacts on agricultural land.

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During the American Dust Bowl of the 1930's, Plains counties experienced substantial erosion that reduced agricultural land values in more-eroded counties, relative to less-eroded counties, and led to relative declines in population through the 1950's (Hornbeck, 2012). During the 1930's, amidst the Great Depression, the notable experiences of migrants to California became associated with those of "Dust Bowl migrants" and they came to represent a breakdown of the American economy.

Dust Bowl migrants became an archetype, refugees displaced by environmental collapse. This lasting impression of Dust Bowl migrants was established, and remains prominent, largely through artistic works: John Steinbeck's novel "The Grapes of Wrath" and its film; Dorothea Lange's photography, including "Migrant Mother, Nipomo, California;" and Woody Guthrie's "Dust Bowl ballads." Quantitative efforts to examine the Dust Bowl migrants have included contemporaneous surveys of migrant families in California (Janow and McEntire, 1940) and subsequent analysis of regional migrants in Census data samples (Gregory, 1989; Long and Siu, 2018). A substantial empirical challenge is that "Dust Bowl migrants," or those induced to move by the Dust Bowl itself, are difficult to identify separately from other migrants in the 1930's who were induced to move by the Great Depression, New Deal policies, agricultural mechanization, broader drought, and other factors (Bogue and Hagood, 1953; Fishback, Horrace and Kantor, 2006; Boustan, Fishback and Kantor, 2010; Gutmann et al., 2016; Sichko, 2021). Understanding who these Dust Bowl migrants were, and how they differed from other migrants in the 1930's, is important to understand this archetypal "environmental refugee" and clarify how migration responded to this environmental collapse. Further, by following both migrants and non-migrants, my analysis can move beyond identifying impacts of the Dust Bowl on more-eroded counties (Hornbeck, 2012) and identify impacts of the Dust Bowl on people from more-eroded counties.

This paper examines the Dust Bowl migration, estimating how the intensity of county-level erosion influenced migration rates and the characteristics of those who migrated. The paper identifies these archetypal "Dust Bowl migrants" and how they differed from other migrants. The analysis uses the full 1940 US Census, which asked people their 1935 county of residence, in comparing migrants to non-migrants in their 1935 county (out-selection) and comparing migrants to natives in their 1940 county (in-selection). These data also allow for the first assessment of how the Dust Bowl impacted wage incomes in 1939, including those who remained and those who migrated.

Migration represents a main potential channel of adaptation to local environmental destruction, and the experiences of migrants and their reception in new locations depends importantly on who migrates in response to this environmental collapse. Migrants are generally "selected" because the relative returns or costs of migration generally differ across individuals. Further, when people can plan for future migration, they may invest more in education or skills that are relatively more productive in new locations. Thus, the people who migrate after unanticipated large shocks may differ from those who migrate in typical circumstances. Environmental shocks may also generate different migration responses than other economic shocks, and permanent environmental changes may generate differential migration responses than temporary environmental disasters. The Dust Bowl migrants are of particular historical interest, as they have become an archetype of environmental refugees, and the Dust Bowl migrants represent a rare opportunity to explore migration responses to a permanent and unanticipated collapse in the local environment.

My empirical analysis compares migrants from more-eroded counties to migrants from less-eroded counties within the same state and with similar pre-1930's characteristics, extending the empirical specification from Hornbeck (2012). I measure migration using individuals' reported county of residence in 1935 and 1940, rather than matching individuals across Censuses, which reduces the potential for spurious migration and includes women in the data. This period of analysis (1935 to 1940) coincides with the core Dust Bowl migration period, though there may have been some additional migration in the early 1930's and after 1940. The empirical analysis cannot identify particular individuals as "Dust Bowl migrants," but my analysis identifies how, on average, the Dust Bowl induced different migrants.

I estimate that migration rates were higher from more-eroded counties than from less-eroded counties. Overall, 7% of 1935 Plains residents had, by 1940, moved to a county more than 200 miles away. This migration rate was 2.6 percentage points higher from high-erosion counties and 1.4 percentage points higher from medium-erosion counties, relative to low-erosion counties within the same state and with similar pre-1930's characteristics. Diverted in-migration also contributed to relative population declines in more-eroded counties, though this effect is statistically insignificant and smaller in magnitude than the increase in out-migration.

Migrants from more-eroded counties moved further and moved to more geographically scattered destinations, as compared to more geographically clustered destinations of migrants from less-eroded counties. These migration patterns suggest an atypical, and perhaps less-planned, migration response to local environmental collapse.

Migration to California was not the typical response (1.65% of 1935 Plains residents), but this migration rate to California was 0.69 percentage points higher from high-erosion counties and 0.50 percentage points higher from medium-erosion counties. I also estimate elevated migration to the Pacific Northwest (Washington, Oregon, Idaho), though the experiences of migrants to California have been more central in popular narratives surrounding Dust Bowl migrants.

Migrants from more-eroded counties were more "negatively selected," in years of education, than other migrants who were generally "positively selected." That is, while migrants generally had more years of education than those who remained in their 1935 counties, this was less true of migrants from more-eroded counties. Further, when focusing only on "Dust Bowl migrants," or only those additional migrants induced to move by higher erosion, they had fewer years of education than non-migrants. Along other characteristics, migrants generally were younger, more likely male, and less likely to have lived on a farm in 1935; and along these characteristics, Dust Bowl migrants were similar to general migrants. Migrants from more-eroded counties were slightly more likely than other migrants to have lived on a farm in 1935, though the Dust Bowl migrants' popular reputation for being agricultural was more shaped by differences from natives in their new destinations.

Migrants from more-eroded counties had lower wage incomes in 1939, compared to natives in their new destinations, than migrants from less-eroded counties. Further, migrants from all Plains counties had substantially lower incomes than natives in California. These patterns appear to have driven popular impressions of the Dust Bowl migrants, often influenced by experiences in California migrant camps.

I estimate strikingly modest impacts of the Dust Bowl on 1939 incomes, however, for all 1935 residents of more-eroded counties. While agricultural land values declined substantially in more-eroded counties, with limited adaptation in local agricultural production (Hornbeck, 2012), I estimate only modest differences in 1939 wage incomes between all 1935 residents of more-eroded counties and less-eroded counties. The impact on 1939 incomes is similar for migrants and non-migrants, particularly after controlling for differences in years of education. The impact on incomes is also smaller for groups that experienced greater migration responses, consistent with migration playing a key role in mitigating the impact of the Dust Bowl on people despite the large and enduring impact of the Dust Bowl on land.

Finally, I explore how impacts of the Dust Bowl on incomes were mitigated or exacerbated by New Deal program spending. Greater AAA spending was associated with a more negative effect of the Dust Bowl on male incomes, whereas public works spending moderately mitigated the impact on male incomes. This spending had little differential impact on female incomes, and relief spending had little impact by 1939. These results are consistent with Fishback, Horrace and Kantor (2005); Liu and Fishback (2019), who find contrasting impacts of public works spending (which generated local manual labor demand) and AAA spending (which reduced local manual labor demand by taking agricultural land out of production). These estimates suggest how policy responses can mitigate or exacerbate the economic consequences of permanent environmental change (see also Balboni, 2021).

The Dust Bowl provides a rare opportunity to explore migration responses to a permanent collapse in the local environment, in contrast to more exploration of migration responses to more-temporary natural disasters and weather shocks (Piguet, Pécoud and de Guchteneire, 2011; Boustan, Kahn and Rhode, 2012; Marchiori, Maystadt and Schumacher, 2012; Bohra-Mishra, Oppenheimer and Hsiang, 2014; Cai et al., 2016; Deryugina, 2017; Deryugina, Kawano and Levitt, 2018; Boustan et al., 2019; Deryugina and Molitor, 2020; Mahajan and Yang, 2020; Spitzer, Tortorici and Zimran, 2020; Sichko, 2021).[1] The migration literature has long considered how migrant selection varies across contexts (Roy, 1951; Borjas, 1987), and characterizing the Dust Bowl migrants and their experiences provides an opportunity to refine the archetype of environmental refugee. Indeed, future changes in climate are expected to generate substantial migrant flows (Stern, 2007), which may have an important role in mitigating economic costs of climate change (Desmet and Rossi-Hansberg, 2015), but these migration responses to environmental collapse may differ from typical migration flows. The Dust Bowl period highlights how a permanent collapse of the local environment generated less positively-selected migrants, who went to different destinations and had lower incomes than natives in their destinations. This substantial migration response was ultimately associated with little impact of environmental collapse on people's incomes, however, which is in contrast to the large and enduring impacts on land's value.

In focusing on migration from environmental collapse, this episode also complements our understanding of how the United States has been influenced by large-scale migration, such as the Great Migration of African Americans to the Northern United States (Collins and Wanamaker, 2014, 2015) and mass migration to the United States (Abramitzky, Boustan and Eriksson, 2012; Abramitzky and Boustan, 2017). Who migrates, and how they differ from natives in their new destinations, influences how migrants are received and what impacts migrants have in those destinations (Boustan, 2009, 2010; Boustan, Fishback and Kantor, 2010; Derenoncourt, 2022).

I Historical Context

Amidst economic turmoil in the 1930's, the United States' Plains experienced widespread severe erosion in what became known as the Dust Bowl. Especially severe droughts in 1934 and 1936, and loss of ground cover, made topsoil susceptible to large dust storms (e.g., "Black Sunday" in 1935) and substantial water erosion during occasional rains. There was uncertainty concerning future regional weather, but local erosion was immediately clear: agricultural land values declined substantially by 1940, in more-eroded counties relative to less-eroded counties, and remained lower with limited adaptation in local agricultural

[1] See Sichko (2021), in particular, for an analysis of migrant selection in response to more-temporary drought in the 1930's United States. Cattaneo and Peri (2016) explore migration responses to long-term warming trends between 1960 and 2000.

production (Hornbeck, 2012).

The Dust Bowl became associated with imagery of displaced farmers migrating to California, which potentially reflects the combined experiences of the Dust Bowl, the Depression, and displacement by mechanization. In 1939, a survey of migrant families in California highlighted this migration from Oklahoma (Janow and McEntire, 1940), with peak arrival years in 1936 and 1937. Migrants became derogatorily referred to as "Okies," though there was also substantial migration from Arkansas ("Arkies") and other non-Plains areas, which suggests these regional migration patterns also reflected factors other than the Dust Bowl.

These migrants faced hostility, and even some efforts to block their entry into California. Stein (1973) argues that, while California had previously received large population inflows, native Californians turned against "Okies" because they were seen as atypically poor and undesirable. Contemporaries considered many of the "lowliest settlers" in California resettlement camps to be refugees from the Dust Bowl (e.g., Cannon, 1996, p. 102).[2]

Gregory (1989) uses the 1940 Census (1% sample) to examine migrants to California, comparing all migrants from a broad region (Oklahoma, Texas, Arkansas, Missouri) to non-migrants and how these "Southwestern" migrants compared to others in California in 1940. Gregory (1989) emphasizes that migration to California had been common, drawing relatively well-off migrants, but that 1935-40 migrants from the Southwest were atypically worse-off. These migrants left for California not only due to the Dust Bowl, Stein and Gregory emphasize, but also mechanization, changing crop prices, and AAA policy.[3] The combined influences of these shocks are a challenge in characterizing "Dust Bowl migrants," or those who migrated because of the Dust Bowl in particular.

Long and Siu (2018) examine 4,210 individuals from 20 "Dust Bowl counties" around the Oklahoma panhandle in 1930, who they compare to a national sample, and examine migration to California and other destinations. Many of these panhandle-region counties experienced severe wind erosion but severe erosion was more widespread in the Plains (Hansen and Libecap, 2004; Hornbeck, 2012) and these panhandle-region counties are outside areas of concentrated migration to California mapped by (Janow and McEntire, 1940).

Long and Siu (2018) emphasize several results, including: (1) farmers were least likely to move from Dust Bowl counties (but not from other counties); (2) migrants from Dust Bowl

[2]There was also notable migration to the Pacific Northwest (Troxell and O'Day, 1940), where the selection of migrants and their experiences were seen as more moderate than for migrants to California (Dewing, 2006).

[3]For recent empirical evidence on other push factors, see Fishback, Horrace and Kantor (2006) and Boustan, Fishback and Kantor (2010). In a more contemporary account, McWilliams (1942) focuses on mechanization and 1935-1939 migration from Oklahoma to California and the Pacific Northwest. Stuart and Taylor (2021) estimate weaker network effects among Plains white migrants than among Southern African American migrants during the Great Migration. See also Collins and Wanamaker (2014, 2015) for an exploration of migrant selection during the Great Migration.

counties were not more likely to go to California; (3) population decline in Dust Bowl counties was mostly due to decreased in-migration rather than increased out-migration; (4) there was negligible selectivity of migrants from Dust Bowl counties, such as in their education and likelihood of living in their birth state (though selection in migration from elsewhere).

I estimate substantially different results along these dimensions: (1) people living on farms were less likely to migrate, in general, and weakly more likely to migrate from more-eroded counties; (2) migrants from more-eroded counties were more likely to go to California; (3) there was diverted in-migration to more-eroded counties, but a larger increase in out-migration from more-eroded counties; (4) there were notable differences among migrants from more-eroded counties, who had less education and were more likely to be living in their birth state. This selection into migration then complicates estimation of returns to migration.

To measure migration, Long and Siu (2018) link individuals from the 1930 Census to the 1940 Census using their name, race, age, and state of birth. False-positive matches would generate spurious migration and, indeed, 52% of panhandle-region residents are indicated to have moved counties. Even if matching errors occur at the same rate across places, and do not vary systematically with individuals' characteristics, inflated migration rates from matching error would attenuate differences in true migration rates across places and attenuate estimated differences between true migrants and non-migrants.

Identifying archetypal "Dust Bowl migrants" is about understanding who was induced to move by the Dust Bowl, and requires a counterfactual for who would have otherwise migrated. The panhandle-region (analyzed in Long and Siu, 2018) and the Southwestern-region (analyzed in Gregory, 1989) differed substantially from other areas of the country, in 1930 and in changes over previous decades, and may have been affected differently by the Depression, AAA policy, mechanization, and changing crop prices among other factors. Long and Siu (2018) emphasize that out-migration from the 1930's panhandle-region was not higher than in the 1920's, but migration declined elsewhere in the 1930's and the 1920's are not a counterfactual for the 1930's. Various 1930's shocks also may have affected areas differently based on their agricultural production and other characteristics.

My analysis draws on Dust Bowl erosion throughout the Plains, comparing migration from more-eroded counties to migration from less-eroded counties within the same states and with similar pre-1930's county characteristics. Building on the empirical specification in Hornbeck (2012), these relative comparisons identify average differences between Dust Bowl migrants and other migrants. This helps separate what historical impressions of Dust Bowl migrants are a phenomenon of the Depression and other events of the 1930's, and in what ways this historical legacy should be attributed to the Dust Bowl itself and local environmental collapse.

Further, by observing all 1935 residents of Plains counties (migrants and non-migrants), my analysis can move beyond estimating impacts of the Dust Bowl on more-eroded land (Hornbeck, 2012) to estimate impacts of the Dust Bowl on people from more-eroded places.

II Data

Figure 1 shows a map of cumulative erosion damage after the Dust Bowl (Hornbeck, 2012). Dark gray areas are high-erosion (>75% topsoil lost), light gray areas are medium-erosion, and white areas are low-erosion (<25% topsoil lost). Because mapped erosion represents cumulative erosion after the Dust Bowl, rather than erosion only during the 1930's, the empirical analysis follows Hornbeck (2012) in controlling for pre-1930's county characteristics so residual variation in erosion reflects differential 1930's erosion.[4] This residual variation in erosion is strongly associated with 1930's declines in county-level land values and population (Hornbeck, 2012).

Individual-level data are from the full 1940 Census, which includes individuals' county of residence in 1940 and 1935. I define the migration rate in county c as the number of people who moved from county c to other counties, from 1935 to 1940, divided by the number of people in 1940 who report living in county c in 1935.

The Census data also include individuals' age, gender, education, whether they lived on a farm in 1935, and whether they lived in their birth state in 1935. I restrict the analysis to individuals aged 25-55 in 1935, focusing on working-age individuals with completed education by 1935. This sample includes 49.4 million individuals in the contiguous US with reported county of residence in 1940 and 1935, or 96.4% of individuals aged 25-55 in 1935. The excluded 3.6% of individuals includes those with missing 1935 location, along with those living in 1935 outside the contiguous US.

County-level data are from the Census of Agriculture and Census of Population (Haines, 2010). These data capture a variety of Plains county characteristics in 1930, 1925, 1920, and 1910: acres of farmland (1930, 1925, 1920, 1910), cropland share of farmland (1930, 1925), population per acre (1930, 1920, 1910), rural population share (1930, 1920, 1910), on-farm population share (1930), farms per acre (1930, 1925, 1920, 1910), average farm size (1930, 1925, 1920, 1910), individual crop shares of total cropland (1930 and 1925, for five crop categories: corn, wheat, hay, cotton, oats/barley/rye), cows per acre (1930, 1925, 1920, 1910), pigs per acre (1930, 1925, 1920, 1910), chickens per acre (1930, 1925, 1920). These characteristics capture pre-trends in county-level population and agricultural production,

[4] The Dust Bowl period ended in 1939: while Worster (1979) reports a substantial wind erosion area in 1940, which was noted by Cunfer (2005) and others since, Cunfer later discovered it was a mistake based on earlier maps of anticipated erosion that did not occur (Hornbeck, 2012).

along with differential effects of shocks during the 1930's such as the Depression, New Deal programs, and agricultural mechanization. These pre-1930's county data are adjusted to county boundaries in 1940, following Hornbeck (2010), and merged with mapped erosion intensity.

III Empirical Specifications

For estimating relative impacts of Dust Bowl erosion on migration rates from Plains counties, I regress the migration rate for county c on the fraction of the county in a high-erosion area (H_c), the fraction of the county in a medium-erosion area (M_c), state fixed effects (α_s), and county characteristics in 1930, 1925, 1920, and 1910 (X_c):

$$(1) \qquad Y_c = \beta_1 H_c + \beta_2 M_c + \alpha_s + \theta X_c + \epsilon_c.$$

Coefficients β_1 and β_2 reflect the difference in migration rates for high-erosion counties and medium-erosion counties, relative to low-erosion counties. Relative impacts of the Dust Bowl are identified from comparing more-eroded counties to less-eroded counties within the same state and with similar pre-1930's characteristics (as specified in Hornbeck (2012) and listed above). The identification assumption is that more-eroded counties would otherwise have experienced similar migration as less-eroded counties, and this assumption is more credible when comparing counties within the same state and with similar characteristics in 1930 and before (i.e., counties with similar changes in population and counties with similar characteristics that would be affected more-similarly by other events in the 1930's).[5] This equation does not estimate aggregate effects of the Dust Bowl, as even low-erosion counties may have been affected, but identifies differences in migration intensity and sets up an analysis of how these additional migrants differed.

For estimating average differences between Plains migrants and non-migrants, I regress individual characteristic Y_{ic} on whether that individual moved from a Plains county in 1935 to a different county in 1940 ($Migrant_i$) and county fixed effects (γ_c):

$$(2) \qquad Y_{ic} = \beta Migrant_i + \gamma_c + \epsilon_{ic}.$$

When county fixed effects reflect individuals' 1935 county, the coefficient β captures out-selection: average differences between Plains migrants and non-migrants from their old origin counties. When county fixed effects reflect individuals' 1940 county, the coefficient β captures

[5]The estimates are not sensitive to also controlling directly for counties' average annual per capita New Deal spending through the AAA, public works, and relief programs (Fishback, Horrace and Kantor, 2006), but New Deal spending is potentially endogenous to 1930's conditions and so these measures are omitted from the main specifications following Hornbeck (2012).

in-selection: average differences between Plains migrants and natives in their new destination counties throughout the contiguous United States.

The main empirical specification then estimates how Dust Bowl erosion induced different migrants, combining equations 1 and 2. For example, while migrants may have more years of education than non-migrants in general, the main empirical specification estimates whether this difference was different for Plains migrants from more-eroded counties and Plains migrants from less-eroded counties. I regress individual characteristic Y_{ic} on whether that individual moved from a Plains county in 1935 to a different county in 1940 ($Migrant_i$), interacted with the fraction of the 1935 county in a high-erosion area (H_c), the fraction of the 1935 county in a medium-erosion area (M_c), 1935 state fixed effects (α_s) and 1935 county characteristics in 1930, 1925, 1920, and 1910 (X_c):

$$\begin{aligned} Y_{ic} &= \beta_1 H_c \times Migrant_i + \beta_2 M_c \times Migrant_i \\ &+ \alpha_s \times Migrant_i + \theta X_c \times Migrant_i + \gamma_c + \epsilon_{ic}. \end{aligned} \tag{3}$$

Coefficients β_1 and β_2 indicate how the selection of Plains migrants from high-erosion counties and medium-erosion counties is different than the selection of Plains migrants from low-erosion counties (within the same state and with similar pre-1930's county characteristics). When county fixed effects (γ_c) reflect individuals' 1935 county, β_1 and β_2 report how out-selection differs for Plains migrants from more-eroded counties relative to Plains migrants from less-eroded counties. When county fixed effects (γ_c) reflect individuals' 1940 county, β_1 and β_2 report how in-selection differs for Plains migrants from more-eroded counties relative to Plains migrants from less-eroded counties.

For individual-level analysis of migrant characteristics, in equations 2 and 3, standard errors are clustered by 1935 county or two-way clustered by 1935 county and 1940 county. For county-level analysis of migration rates, in equation 1, specifications are weighted by county population in 1935.[6]

IV Results

IV.A Migration Rates

Table 1 reports that 17% of people moved counties between 1935 and 1940 (Panel A, column 1), among the 6.5 million sample people living in the 843 Plains counties in 1935. This migration rate is 3.1 percentage points higher for people from high-erosion counties (Panel A, column 2) and 1.9 percentage points higher for people from medium-erosion counties

[6] Adjusting for spatial correlation across counties (Conley, 1999), assuming spatial correlation declines linearly to a distance cutoff and is zero thereafter, estimated standard errors for county-level migration rates are 10-20% larger for distance cutoffs between 200 and 400 miles.

(Panel A, column 3), relative to people from low-erosion counties (within the same state and with similar pre-1930's county characteristics, from estimating equation 1). These estimates imply the migration rate is 1.2 percentage points higher for people from high-erosion counties relative to people from medium-erosion counties.[7]

This higher migration from more-eroded counties was concentrated among people moving to counties more than 200 miles from their origin county (Table 1, Panel B).[8] Over this period, 7.2% of people moved more than 200 miles (Column 1), and this migration was higher from more-eroded counties: 2.6 percentage points higher from high-erosion counties (Column 2) and 1.4 percentage points higher from medium-erosion counties (Column 3), relative to low-erosion counties. By contrast, while 9.9% of people moved to counties within 200 miles (Panel C, Column 1), this movement among nearby counties was more similar from more-eroded and less-eroded counties (Panel C, Columns 2 and 3). Thus, while moving among nearby counties was relatively common over this period, the increase in migrants moving more than 200 miles more directly relates to additional migration induced by the Dust Bowl.

Of particular interest is long-distance migration to California. Overall, 1.65% of people moved from Plains counties to California (Panel D, Column 1). This migration to California was 0.69 percentage points higher for people from high-erosion counties and 0.50 percentage points higher for people from medium-erosion counties, relative to people from low-erosion counties. These estimates imply the Dust Bowl induced 63,000 additional migrants to California from high-erosion and medium-erosion counties, relative to low-erosion counties.[9] This estimate should be lower than aggregate migration to California induced by the Dust Bowl, as the Dust Bowl likely increased migration from low-erosion counties also, but I focus on these additional Dust Bowl migrants from more-eroded counties to distinguish their characteristics from those of other migrants.

Panel E reports there was also somewhat elevated migration to the Pacific Northwest (Washington, Oregon, Idaho), though migration to California was substantively larger and has been more central in shaping popular impressions of Dust Bowl migrants. Panel F reports there was less in-migration to more-eroded counties, which helps to explain an additional

[7]These estimates are weighted by county population, and are moderately larger when unweighted. Estimates are similar for men and women, separately, with moderately higher migration rates among men.

[8]This distance is measured between county centroids.

[9]This estimate is similar to a scenario of 72,000 additional migrants to California considered by Boustan, Fishback and Kantor (2010), though that number comes from overall migration flows to California from Oklahoma, Texas, Arkansas, and Missouri in the 1930s relative to the 1920s (from Gregory, 1989). The 63,000 number reflects my estimated relative increase in migration rates multiplied by the total population in high-erosion areas (2.6 million) and medium-erosion areas (8.9 million), calculated from multiplying county populations by the fraction of county area in high-erosion or medium-erosion areas.

portion of the relative population declines in more-eroded counties (from Hornbeck, 2012), though this diverted in-migration is smaller in magnitude than the impact on out-migration and itself not statistically significant.

For subsequent tables, I define "migrants" as those who moved to counties more than 200 miles from their origin Plains county. This definition excludes those moving across nearby county boundaries, or moving within counties, and focuses on the elevated rates of migration associated with higher Dust Bowl erosion.[10]

Table 2 explores further the migration patterns of those leaving more-eroded counties. Panel A reports that migrants from more-eroded counties moved farther than migrants from less-eroded counties, even within those who migrated more than 200 miles from their origin county. Panel B reports that migrants from more-eroded counties had less geographically clustered destinations than migrants from less-eroded counties, based on a constructed index of geographical clustering in counties' migrant destinations (see table notes). These migration patterns suggest an atypical, and perhaps less-planned, migration response to local environmental destruction than other migration from less-eroded counties.

IV.B Out-Selection of Dust Bowl Migrants

Plains migrants were "positively selected," on average, with roughly one more year of education than non-migrants from their 1935 origin county (Table 3, Column 1). This difference is similar for men (1.11 years) and women (1.02 years), from estimating equation 2. Indeed, more-educated people are generally more geographically mobile in the United States (see, e.g., Bogue and Hagood, 1953, Collins, 2007, Hornbeck and Moretti, 2021).[11]

By contrast, the Dust Bowl induced migration among people with fewer years of education. Migrants from more-eroded counties were less "positively selected," in years of education, than migrants from less-eroded counties (Columns 2 and 3). Male migrants from high-erosion counties averaged 0.51 fewer years of education relative to non-migrants from their counties, compared to the difference in years of education between migrants and non-migrants from low-erosion counties (within the same state and with similar pre-1930's characteristics, from estimating equation 3).

Under an additional assumption, these estimates can be used to recover the selection of "Dust Bowl migrants" only (i.e., only those migrants induced to move by the Dust Bowl erosion). If we assume that higher erosion only induced additional migrants, and did not also discourage some from migrating, then estimates from Table 1 imply that additional

[10] This definition of "migrants" also excludes seasonal migrants and return migrants. For Tables 3 and 4, "non-migrants" are those who remained in their 1935 county, though estimates are similar when "non-migrants" includes those who moved within 200 miles.

[11] In an early analysis of migration between 1935 and 1940, Bogue and Hagood (1953) highlight this "positive selection of the better educated."

Dust Bowl migrants were 30% of all migrants from high-erosion counties (and 18% of all migrants from medium-erosion counties).[12] To recover the selection of these additional Dust Bowl migrants, induced to move by higher-erosion and driving the differences estimated in Table 3, estimates from column 2 of Table 3 would then be scaled-up by 3.33 (1/0.30): male Dust Bowl migrants from high-erosion counties averaged 1.7 fewer years of education relative to non-migrants in high-erosion counties, compared to the difference between migrants and non-migrants from low-erosion counties.[13]

Dust Bowl migrants were then "negatively selected" in absolute terms, compared to non-migrants. Male Dust Bowl migrants from high-erosion counties were less positively selected than migrants from low-erosion counties (-1.7 years), whereas average male migrants were positively selected (1.1 years), implying Dust Bowl migrants also had less education than non-migrants. These estimates are similar for female migrants: whereas migrants were generally positively selected, Dust Bowl migrants were negatively selected in years of education.

Plains migrants to California also averaged more years of education than non-migrants (Column 4), though these migrants were less positively selected than migrants to all counties (Column 1). Migrants to California from more-eroded counties were less positively selected than migrants to California from less-eroded counties (Columns 5 and 6) and "Dust Bowl migrants" moving to California were negatively selected, in absolute terms, compared to non-migrants.[14]

Plains migrants were also less likely than non-migrants to have been living in their birth state in 1935 (Column 1), though this was less true for migrants from more-eroded counties than for migrants from less-eroded counties (Columns 2 and 3). In other respects, Dust Bowl migrants were more similar to general migrants: less likely to have lived on a farm in 1935, younger, and more likely male.

Appendix Table 1 reports the selection of "local migrants," or those who moved to counties within 200 miles. The rate of local migration was similar from more-eroded and less-eroded counties (Table 1, Panel C), and Appendix Table 1 reports little difference in years of education for migrants from more-eroded and less-eroded counties.[15] This is consistent

[12]This calculation reflects the estimated increase in migration from high-erosion counties relative to low-erosion counties (Table 1, Column 2, Panel B), as a share of the average migration rate from high-erosion counties (where column 1 reflects a population-weighted average in high-erosion, medium-erosion, and low-erosion counties).

[13]Male Dust Bowl migrants from high-erosion and medium-erosion counties were similarly different (-1.7 years and -2.0 years), after scaling the estimates, because the different scaling factors adjust for differences in migration intensity.

[14]Estimates from Table 1 imply that additional Dust Bowl migrants to California were 35% of all migrants to California from high-erosion counties (and 28% of all migrants to California from medium-erosion counties), under the assumption that higher erosion only induced additional migration to California.

[15]There is also little difference along other dimensions, with the exception that local migrants from more-

with the assumption above, that the Dust Bowl largely induced additional migrants and other migrants remained similar. If higher erosion also discouraged some from migrating, then "Dust Bowl migrants" would be a higher share of all migrants and the implied scaling factor used above would be closer to one.[16]

Appendix Table 2 broadens the analysis to compare migrants and non-migrants from the Plains region and non-Plains regions. As in Table 3, Plains migrants average more years of education than non-migrants (Column 3). This difference is even greater in non-Plains regions (Column 6), such that all Plains migrants are less positively-selected than all non-Plains migrants (Column 7).

IV.C In-Selection of Dust Bowl Migrants

Dust Bowl migrants' reputation for having been agricultural appears to reflect differences from natives in their new counties (Table 4), more than differences from non-migrants in their origin counties (Table 3). Migrants from more-eroded counties were more likely to have lived on a farm in 1935 than migrants from less-eroded counties, compared to natives in their destination counties (Table 4, Row 1, Columns 2-3 and 5-6). Further, while all Plains migrants were no more likely than natives to have lived on a farm (Column 1), all Plains migrants to California were 12 percentage points more likely to have lived on a farm in 1935 than natives in their California counties (Column 4). From Californians' perspective, which largely shaped popular impressions of the Dust Bowl migrants: more migrants were arriving from more-eroded counties; all Plains migrants to California had a more agricultural background than natives; and Dust Bowl migrants had a more agricultural background, relative to natives, than was typical of other Plains migrants. By 1940, however, migrants had shifted from agriculture: all Plains migrants became less likely than natives to live on a farm, weakly so in California, and migrants from more-eroded counties were not as disproportionately living on a farm in 1940.

Dust Bowl migrants had lower incomes in 1939, relative to natives, and especially in California. This reflects two effects: migrants from more-eroded counties had lower incomes than migrants from less-eroded counties, and all Plains migrants had lower incomes than natives in California especially.[17] Migrants from more-eroded counties also had fewer years of education, relative to natives, than migrants from less-eroded counties. There continue

eroded counties are less likely to have been living on a farm, perhaps because nearby agricultural opportunities are more limited and some move further.

[16] This scaling factor would equal one if all migrants from high-erosion counties would otherwise not have migrated and entirely different people would have migrated.

[17] When analyzing impacts on income, the sample is restricted to people working 26+ weeks (full-time equivalent): 82% of sample men and 22% of sample women. As indirect measures of income and consumption, I also estimate that migrants from more-eroded counties had lower rental expenditures (for renters) and lower home values (for homeowners).

to be income differences, however, after controlling for "skill" (years of education, age, age-squared).[18] Reinforcing this effect, all Plains migrants averaged substantially lower skill-adjusted incomes than natives (especially in California).[19]

IV.D Dust Bowl Impact on Wage Incomes

I estimate remarkably modest impacts of the Dust Bowl on 1939 wage incomes of people from more-eroded counties, given the lower incomes of Dust Bowl migrants (relative to natives) and the substantial impacts of Dust Bowl erosion on agricultural land value and revenue in more-eroded counties. Table 5, Panel A, compares 1939 wage incomes for all those living in more-eroded counties in 1935 to all those living in less-eroded counties in 1935 (within the same state and controlling for pre-1930's county characteristics, as in equation 1).

Average wage incomes in 1939 were a statistically insignificant 1.3% lower for people from high-erosion counties relative to people from low-erosion counties (Panel A, Column 1). The Dust Bowl's effect on wage incomes is moderately more negative for people from medium-erosion counties and for the smaller number of women working 26+ weeks (Panel B), but the magnitudes are small in contrast to much larger impacts on agricultural revenues and land values in high-erosion counties (27% and 30%) and medium-erosion counties (16% and 17%) estimated by Hornbeck (2012). The 1940 Census reports only wage and salary income in 1939, which would not include impacts on agricultural profits, but given some labor mobility across occupations these estimated impacts on labor income suggest substantially smaller impacts of the Dust Bowl on people than on land. A key difference is that people can move following local environmental destruction, whereas land is fixed.

Panels A and B pool all migrants and non-migrants, based on their 1935 location, because of the differential selection of migrants and their destinations. The clearest causal impact of the Dust Bowl on wage incomes would then not condition on endogenous migration decisions.[20] Indeed, previous research was unable to follow migrants and focused on how *land* was affected by the Dust Bowl (Hornbeck, 2012) rather than how *people* were affected by the Dust Bowl.

To further explore these income differences, however, Panel C reports differences in 1939 wage incomes for migrants and non-migrants. Migrants from more-eroded counties have modestly lower incomes than migrants from less-eroded counties, whereas there is less differ-

[18] In California, female migrants from more-eroded counties did not have lower wage incomes, relative to natives, though they worked more weeks. Migrant men worked fewer weeks in 1939, relative to natives, and this difference is similar for male migrants from more-eroded and less-eroded counties.

[19] Plains migrants were generally more educated than natives in their 1940 county, but not in California (Columns 1 and 4).

[20] See (Ward, 2020) for an exploration of income differences for migrants and non-migrants, including for migrants from Dust Bowl counties.

ence in incomes for non-migrants from more-eroded and less eroded counties. Migrants from more-eroded counties had fewer years of education, however, and Panel D reports the reverse pattern when controlling for individuals' years of education, age, and age-squared (i.e., "skill" in Mincer earnings regressions). Overall, migrants and non-migrants' wage incomes were similarly affected in more-eroded counties in a manner consistent with this migration providing an outlet to mitigate the economic impacts of the Dust Bowl.

Panels E and F report impacts on 1939 wage incomes when splitting the sample by education and farm status, which suggests less impact on incomes of demographic groups that had more migration response. Migrants and non-migrants were also affected similarly, within demographic group, consistent with migration equalizing labor market impacts.

Table 6 reports how impacts of the Dust Bowl on incomes were mitigated or exacerbated by New Deal program spending from 1933 to 1939. Panel A reports that male incomes fell by 6.1% more in more-eroded counties that had one standard deviation greater per capita spending through the Agricultural Adjustment Administration (AAA). Greater public works spending was associated with moderately higher male incomes in more-eroded counties, whereas relief spending had little impact by 1939 and there was little differential impact on female incomes (Panel B). These results are consistent with AAA spending reducing local manual labor demand by taking agricultural land out of production, whereas public works spending generated local manual labor demand (Fishback, Horrace and Kantor, 2005; Liu and Fishback, 2019). These estimates suggest how policy responses can mitigate or exacerbate the economic consequences of permanent environmental change (see also Balboni, 2021).

V Conclusion

Dust Bowl migrants are an enduring archetype of environmental refugees, having left areas of the United States' Plains that experienced severe erosion in the 1930's. While impressions of Dust Bowl migrants influence perceptions of migration responses to environmental collapse, this Dust Bowl migration is difficult to identify separately from the influences of other events in the 1930's (e.g., the Great Depression, New Deal policies, changing crop prices, agricultural mechanization). These other factors influence both artistic depictions and quantitative analyses of migrants from the Southwest (Gregory, 1989) or panhandle region (Long and Siu, 2018).

My analysis compares migrants from more-eroded counties to migrants from less-eroded counties, within the same state and with similar pre-1930's county characteristics, to identify the relative increase in migration induced by the Dust Bowl and how the Dust Bowl changed the selection of migrants. I estimate a substantial migration response to the Dust Bowl, which generated distinctive environmental refugees, but was ultimately associated with remarkably modest impacts of the Dust Bowl on wage incomes of people from more-eroded counties in comparison to the substantial and enduring impacts of the Dust Bowl on agricultural land in more-eroded counties.

Dust Bowl migrants were "negatively selected," with fewer years of education, in contrast to typical migrants who were "positively selected" and averaged more years of education than non-migrants. In this sense, these environmental refugees were atypical of general migrants in this era, more pushed from more-eroded counties than pulled to economic opportunities. This atypical selection of migrants suggests why these particular migrants generated unusually hostile local reactions in their destinations.

I estimate increased migration to California from more-eroded counties, which is only one component of the general migration response to the Dust Bowl, but which has been central to popular impressions formed of Dust Bowl migrants. These impressions of Dust Bowl migrants partly reflected average migrant experiences in California, where migrants had substantially lower incomes than natives, and migrants from more-eroded counties were also more likely than natives to have lived on a farm in 1935.

There was ultimately little impact of the Dust Bowl on 1939 wage incomes, however, for people living in more-eroded counties in 1935 relative to people living in less-eroded counties in 1935. Further, the Dust Bowl had similar impacts on 1939 wage incomes of migrants and non-migrants. Later Censuses or Social Security records may allow for further analysis of longer-term impacts on Dust Bowl migrants and their children, though it would be important to consider endogenous selection into migration from more-eroded counties.[21]

Whereas Hornbeck (2012) estimates only slow and limited adaptation of local agricultural production in more-eroded counties, and enduring declines in agricultural land values, the migration of these "environmental refugees" was ultimately associated with little average impact on all original residents' wage incomes from the permanent collapse of the local environment. These environmental refugees were distinctive in their characteristics and destinations, however, which suggests a more unusual disruption and migration response following local environmental collapse.

[21] Arthi (2018) explores long-term impacts on people born in states more-exposed to Dust Bowl erosion.

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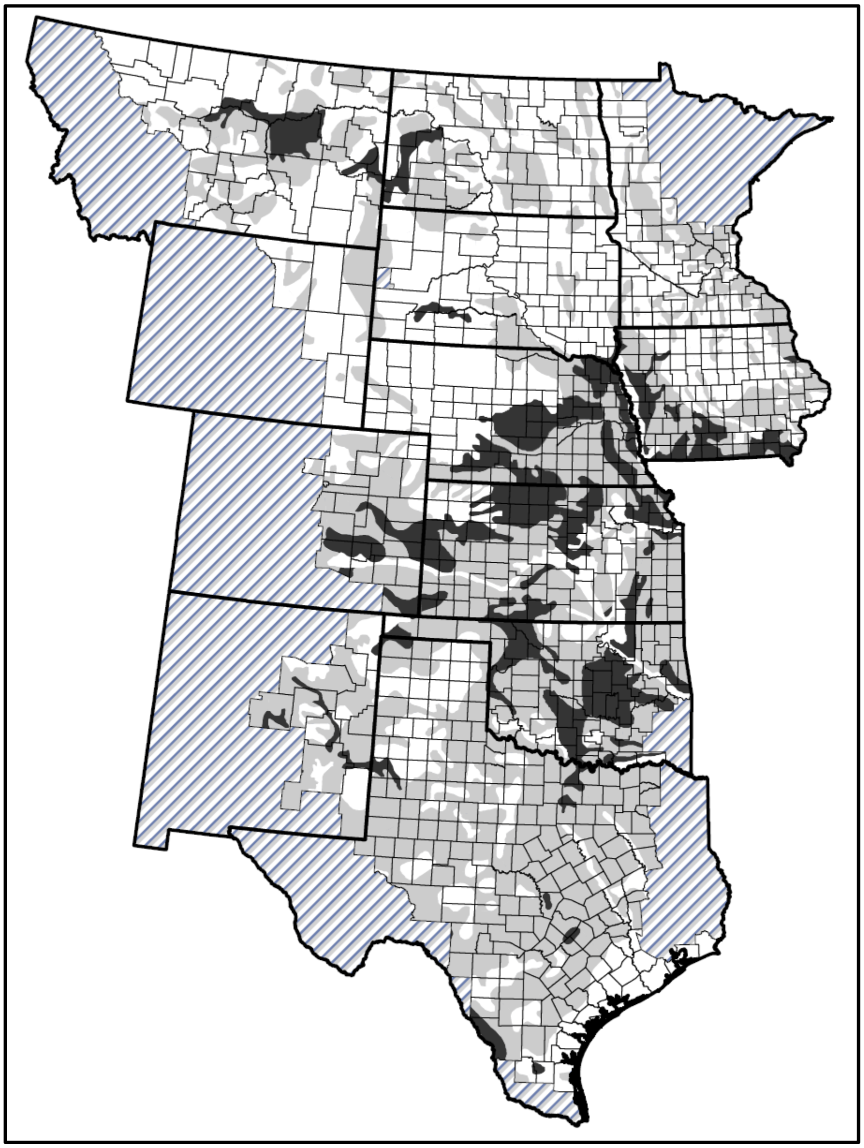
Figure 1. The 843 Plains Counties, Shaded by Erosion Level



Notes: The mapped erosion levels are low (shaded white, less than 25% of topsoil lost), medium (shaded light gray, 25% to 75% of topsoil lost), or high (shaded dark gray, more than 75% of topsoil lost). Thin lines denote 1940 county borders, corresponding to 843 counties in this Plains region. Thick lines denote state boundaries. Crossed out areas are not in the Plains region. The Plains region is defined to be this contiguous set of 843 counties from these 12 States (Colorado, Iowa, Kansas, Minnesota, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming) that have 50 percent or more of their area in the typical central United States grassland and forest vegetation regions (Tall Grass, Short Grass, Mesquite Grass, Mesquite and Desert Grass Savanna, and Oak-Hickory Forest) as mapped by the USDA's 1924 *Atlas of Agriculture*. Source: National Archives (College Park, MD), RG 114, Cartographic Records of the Soil Conservation Service, #149.

Table 1. Estimated Migration From 1935 to 1940, by Original County Erosion Level

		Relative to Low Erosion Counties:	
	All Plains Counties (1)	High-Erosion Counties (2)	Medium-Erosion Counties (3)
Panel A. Migration To All Counties			
Migration Percent	17.05	3.05	1.86
	[5.19]	(0.64)	(0.46)
Panel B. Migration Beyond 200 Miles			
Migration Percent	7.19	2.56	1.37
	[3.82]	(0.46)	(0.33)
Panel C. Migration Within 200 Miles			
Migration Percent	9.86	0.49	0.49
	[3.41]	(0.39)	(0.28)
Panel D. Migration to California			
Migration Percent	1.65	0.69	0.50
	[1.15]	(0.12)	(0.09)
Panel E. Migration to Pacific Northwest			
Migration Percent	0.82	0.38	0.14
	[1.17]	(0.12)	(0.09)
Panel F. Diverted in-Migration			
Migration from counties > 200 miles	4.16	-1.01	-0.46
	[4.51]	(0.71)	(0.52)
Migration from counties < 200 miles	9.66	-1.29	-0.84
	[4.71]	(0.81)	(0.59)

Notes: For 843 Plains counties (Figure 1), county-level migration rates are defined for all individuals residing in these counties in 1935, ages 25 to 55 in 1935, that report county of residence in 1935 and 1940. Panel A reports the number of migrants leaving a county between 1935 and 1940, as a percent of that county's sample population in 1935. Panel B reports the corresponding number for migrants who leave their county and move to a county further than 200 miles away, and Panel C reports the corresponding number for migrants who leave their county and move to a county within 200 miles. Panel D reports the number of migrants going to California, as a percent of 1935 county sample population. Panel E reports the number of migrants going to the Pacific Northwest (Washington, Oregon, Idaho) as a percent of 1935 county sample population. Panel F reports the number of migrants entering a county between 1935 and 1940, as a percent of that county's population in 1935, split into migrants coming from a county more than 200 miles away and migrants coming from a county less than 200 miles away.

Column (1) reports the average across all 843 Plains counties, weighting by county population in 1935, with standard deviations reported in brackets. For each row, columns (2) and (3) report the coefficients from estimating equation 1: regressing the migration percent on the fraction of the county in a high-erosion area and the fraction of the county in a medium-erosion area (low-erosion is the omitted category), controlling for state fixed effects and a vector of county-level characteristics in 1930, 1925, 1920, and 1910 (from Hornbeck 2012). These county-level regressions are weighted by county population in 1935, and robust standard errors are reported in parentheses.

Table 2. Differences in Migration Patterns, by County Erosion Level

		Relative to Low-Erosion Counties:	
	All Plains Counties	High-Erosion Counties	Medium-Erosion Counties
	(1)	(3)	(2)
Panel A. Distance Migrated			
Average Distance Migrated, in miles	726	32.3	23.6
	[134]	(14.8)	(10.7)
Panel B. Clustering of Migrants			
Index of Geographic Clustering	0	-0.291	-0.230
	[1]	(0.151)	(0.106)

Notes: The sample is 843 Plains counties (Figure 1) for which county-level outcome variables are defined based on the destinations of those counties' migrants (1935 residents of each county who lived in a different county by 1940, at least 200 miles away). In Panel A, the outcome variable is the average distance between migrants' 1935 county and 1940 county. In Panel B, the outcome variable is an index of geographic clustering in migrant destinations, normalized to have a mean of zero and standard deviation of one. For each 1935 county, I calculate the share of migrants that go to each county in 1940. For that 1935 county's state, I calculate the share of migrants from that state that go to each county in 1940. I then take the squared difference between these two measures, and create the index for each 1935 county by summing across all 1940 destinations. This creates an index of how much migrants from a particular county are concentrated in particular destinations, as compared to general destinations of migrants from that state.

Column 1 reports the sample mean of the outcome variable in each panel. Columns 2 and 3 report coefficients from estimating equation 1: regressing the indicated outcome variable in each Panel on the fraction of the 1935 county in a high-erosion area and medium-erosion area (low-erosion is the omitted category), and controlling for 1935 state fixed effects and 1935 county characteristics (in 1930, 1925, 1920, 1910). Robust standard errors are reported in parentheses.

Table 3. Estimated Out-selection of Migrants, by Original County Erosion Level

Outcome:	Migrants to All Counties			Migrants to California Counties Only		
		Relative to Low-Erosion:			Relative to Low-Erosion:	
	Migrants from All Plains Counties	Migrants from High-Erosion Counties	Migrants from Med-Erosion Counties	Migrants from All Plains Counties	Migrants from High-Erosion Counties	Migrants from Med-Erosion Counties
	(1)	(2)	(3)	(4)	(5)	(6)
Years of Education						
Men	1.11	-0.51	-0.37	0.54	-0.54	-0.35
	(0.06)	(0.13)	(0.10)	(0.08)	(0.13)	(0.10)
Women	1.02	-0.43	-0.37	0.48	-0.48	-0.38
	(0.05)	(0.13)	(0.10)	(0.07)	(0.14)	(0.11)
Percent Living in	-8.47	2.57	1.90	-2.84	1.06	1.20
Birth State in 1935	(0.64)	(1.38)	(1.03)	(0.69)	(1.54)	(1.11)
Percent Living on	-9.79	1.31	0.93	-8.80	2.28	0.75
a Farm in 1935	(0.68)	(1.40)	(0.97)	(0.91)	(1.69)	(1.36)
Age	-2.95	0.08	-0.10	-2.75	0.24	-0.07
	(0.04)	(0.14)	(0.10)	(0.04)	(0.20)	(0.16)
Percent Male	3.65	-0.33	-0.46	1.62	-0.69	-0.43
	(0.21)	(0.40)	(0.32)	(0.29)	(0.57)	(0.51)

Notes: For Columns 1 - 3, a migrant is someone who lived in different counties in 1935 and 1940 (at least 200 miles apart) and a non-migrant is someone who lived in the same county in 1935 and 1940. The sample is restricted to people who lived in 1935 within the 843 Plains counties (Figure 1). For Columns 4 - 6, the definition of migrants is further restricted to those who migrated to counties in California between 1935 and 1940.

For the indicated outcome variable (in rows), column 1 reports estimates from equation 2: the estimated coefficient on a "migrant" indicator, controlling for 1935 county fixed effects. From estimating equation 3, columns 2 and 3 report coefficients on the "migrant" indicator, interacted with the fraction of the person's 1935 county in a high-erosion area and medium-erosion area (low-erosion is the omitted category), and controlling for: 1935 county fixed effects, interactions between the "migrant" indicator and 1935 state fixed effects, and interactions between the "migrant" indicator and 1935 county characteristics (in 1930, 1925, 1920, 1910). Columns 4 - 6 report analogous estimates, but restricting the definition of migrant to include only those who migrated to counties in California.

For these individual-level regressions, robust standard errors clustered by 1935 county are reported in parentheses.

Table 4. Estimated In-selection of Migrants, by Original County Erosion Level

	Migrants to All Counties			Migrants to California Counties Only		
		Relative to Low-Erosion:			Relative to Low-Erosion:	
	Migrants from All Plains Counties	Migrants from High-Erosion Counties	Migrants from Med-Erosion Counties	Migrants from All Plains Counties	Migrants from High-Erosion Counties	Migrants from Med-Erosion Counties
Outcome:	(1)	(2)	(3)	(4)	(5)	(6)
Percent Living on a Farm						
in 1935	0.81	3.24	2.06	12.00	3.70	1.98
	(1.74)	(1.31)	(0.98)	(1.74)	(1.37)	(1.00)
in 1940	-5.01	1.00	0.84	-1.67	2.50	0.14
	(0.70)	(0.79)	(0.63)	(1.11)	(1.18)	(1.15)
Years of Education						
Men	1.14	-0.34	-0.28	-0.02	-0.23	-0.25
	(0.15)	(0.17)	(0.09)	(0.12)	(0.12)	(0.07)
Women	1.12	-0.26	-0.28	0.05	-0.14	-0.25
	(0.15)	(0.15)	(0.08)	(0.13)	(0.11)	(0.09)
Log Income in 1939						
Men	-0.017	-0.078	-0.071	-0.340	-0.077	-0.043
	(0.039)	(0.029)	(0.017)	(0.031)	(0.033)	(0.023)
Women	-0.156	-0.073	-0.044	-0.380	0.000	-0.022
	(0.047)	(0.040)	(0.021)	(0.017)	(0.038)	(0.024)
Log Income in 1939, Skill-Adjusted						
Men	-0.093	-0.051	-0.050	-0.318	-0.063	-0.027
	(0.025)	(0.022)	(0.013)	(0.026)	(0.028)	(0.020)
Women	-0.214	-0.051	-0.030	-0.346	0.008	-0.021
	(0.028)	(0.024)	(0.018)	(0.009)	(0.033)	(0.025)
Weeks Worked						
Men	-2.16	-0.12	-0.00	-4.92	-0.17	0.32
	(0.25)	(0.29)	(0.19)	(0.80)	(0.56)	(0.41)
Women	-0.48	0.26	0.48	0.25	0.83	0.44
	(0.30)	(0.42)	(0.26)	(0.57)	(0.43)	(0.36)

Notes: For Columns 1 - 3, a migrant is someone who lived in different counties in 1935 and 1940, at least 200 miles apart, and lived in 1935 within the 843 Plains counties (Figure 1). A non-migrant is someone who lived in the same county in 1935 and 1940, within all counties in the contiguous United States. For Columns 4 - 6, the sample is further restricted to migrants from the 843 Plains counties to California and non-migrants in California counties only.

For the indicated outcome variable (in rows), column 1 reportes estimates from equation 2: the estimated coefficient on a "migrant" indicator, controlling for 1940 county fixed effects. From estimating equation 3, columns 2 and 3 report coefficients on the "migrant" indicator, interacted with the fraction of the person's 1935 county in a high-erosion area and medium-erosion area (low-erosion is the omitted category), and controlling for: 1940 county fixed effects, interactions between the "migrant" indicator and 1935 state fixed effects, and interactions between the "migrant" indicator and 1935 county characteristics. Skill-adjusted income is defined by controlling for individuals' years of education, age, and age-squared.

For these individual-level regressions, robust standard errors two-way clustered by 1935 county and 1940 county are reported in parentheses.

Table 5. Estimated Log Income Differences in 1939, by Original County Erosion Level

	Average Income (1)	Relative to Low-Erosion Counties: High-Erosion Counties (3)	Relative to Low-Erosion Counties: Medium-Erosion Counties (2)
Panel A. All 1935 Residents of the Plains			
Men and Women	$1,220	-0.013	-0.028
	[882]	(0.027)	(0.016)
Panel B. All 1935 Residents of the Plains, by Gender			
Men	$1,316	-0.007	-0.027
	[923]	(0.030)	(0.018)
Women	$847	-0.041	-0.028
	[559]	(0.023)	(0.014)
Panel C. By Migration Status			
Migrants	$1,318	-0.055	-0.053
	[976]	(0.026)	(0.015)
Non-Migrants	$1,210	-0.023	-0.032
	[870]	(0.031)	(0.018)
Panel D. By Migration Status, Skill-Adjusted Income			
Migrants	$1,318	-0.030	-0.034
	[976]	(0.017)	(0.012)
Non-Migrants	$1,210	-0.047	-0.063
	[870]	(0.024)	(0.015)
Panel E. By Education			
Education ≤ 8 years	$959	0.013	-0.032
	[700]	(0.035)	(0.020)
Education > 8 years	$1,456	-0.053	-0.060
	[960]	(0.018)	(0.013)
Panel F. By Farm Status			
On Farm in 1935	$728	0.032	0.023
	[613]	(0.035)	(0.018)
Off Farm in 1935	$1,296	-0.021	-0.046
	[888]	(0.028)	(0.017)

Notes: The sample includes all people who were living in 1935 within the 843 Plains counties (Figure 1), ages 25 to 55 in 1935, who report county of residence in 1935 and 1940, and report working 26+ weeks in 1939 (equivalent full-time weeks). Panel A reports estimates for a pooled sample of men and women, interacting all control variables with gender, and Panel B reports estimates separately by gender. Panel C reports estimates separately for migrants (who moved more than 200 miles) and non-migrants (who live in the same county), and Panel D reports estimates by migration status when controlling for individuals' years of education, age, and age-squared. Panel E reports estimates separately for those with less than or equal to 8 years of education and those with more than 8 years of education, and Panel F reports estimates separately for those living on a farm in 1935 and those not living on a farm in 1935.

Column 1 reports average 1939 wage and salary income, in levels, with standard deviations reported in brackets. As in equation 1, columns 2 and 3 report the coefficients from regressing log income on the fraction of the person's 1935 county in a high-erosion area and medium-erosion area (low-erosion is the omitted category), controlling for 1935 state fixed effects and 1935 county characteristics (in 1930, 1925, 1920, and 1910). For these individual-level regressions, robust standard errors two-way clustered by 1935 county and 1940 county are reported in parentheses.

Table 6. Estimated Log Income Differences in 1939, by Original County Erosion Level, Interacted with New Deal program spending

	Average Income (1)	Relative to Low-Erosion Counties: High-Erosion Counties (2)	Medium-Erosion Counties (3)
Panel A. Male 1935 Residents of the Plains			
Main Effect of Erosion	$1,316	-0.012	-0.011
	[924]	(0.023)	(0.016)
Interacted With AAA spending		-0.061	0.005
		(0.033)	(0.018)
Interacted With Public Works spending		0.039	-0.006
		(0.022)	(0.018)
Interacted with Relief spending		-0.010	0.025
		(0.032)	(0.019)
Panel B. Female 1935 Residents of the Plains			
Main Effect of Erosion	$847	-0.031	-0.016
	[559]	(0.021)	(0.014)
Interacted With AAA spending		0.016	0.030
		(0.024)	(0.017)
Interacted With Public Works spending		0.013	0.010
		(0.026)	(0.018)
Interacted with Relief spending		0.000	-0.003
		(0.034)	(0.017)

Notes: This table reports estimates similar to those from Table 5, but interacting county erosion with counties' level of per-capita spending on New Deal programs (AAA, Public Works, Relief). New Deal spending is normalized to have a mean of zero and standard deviation of one. The sample includes all people who were living in 1935 within the 843 Plains counties (Figure 1), ages 25 to 55 in 1935, who report county of residence in 1935 and 1940, and report working 26+ weeks in 1939 (equivalent full-time weeks). Panels A and B report estimates for men and women, interacting all control variables with gender.

Column 1 reports average 1939 wage and salary income, in levels, with standard deviations reported in brackets. As in equation 1, columns 2 and 3 report the coefficients from regressing log income on the fraction of the person's 1935 county in a high-erosion area and medium-erosion area (low-erosion is the omitted category), along with interactions between county erosion and New Deal program spending, controlling for main effects of New Deal program spending and 1935 state fixed effects and 1935 county characteristics (in 1930, 1925, 1920, and 1910). For these individual-level regressions, robust standard errors two-way clustered by 1935 county and 1940 county are reported in parentheses.

Appendix Table 1. Estimated Out-selection of Local Migrants, by Original County Erosion Level

	Migrants to All Counties		
		Relative to Low-Erosion:	
	Migrants from All Plains Counties	Migrants from High-Erosion Counties	Migrants from Med-Erosion Counties
Outcome:	(1)	(2)	(3)
Years of Education			
Men	0.74	0.11	0.00
	(0.03)	(0.08)	(0.05)
Women	0.73	0.08	-0.00
	(0.02)	(0.08)	(0.05)
Percent Living in Birth State in 1935	-1.57	0.39	1.08
	(0.26)	(0.86)	(0.60)
Percent Living on a Farm in 1935	-5.05	-3.43	-1.05
	(0.41)	(1.27)	(0.77)
Age	-2.64	-0.06	-0.07
	(0.03)	(0.11)	(0.08)
Percent Male	2.90	-0.67	-0.18
	(0.14)	(0.31)	(0.20)

Notes: Columns 1 - 3 reproduce columns 1 - 3 in Table 3, but for "local migrants" who lived in different counties in 1935 and 1940 less than 200 miles apart (compared to non-migrants, who lived in the same county in 1935 and 1940). The sample is restricted to people who lived in 1935 within the 843 Plains counties (Figure 1).

For the indicated outcome variable (in rows), column 1 reports estimates from equation 2: the estimated coefficient on a "local migrant" indicator, controlling for 1935 county fixed effects. From estimating equation 3, columns 2 and 3 report coefficients on the "local migrant" indicator, interacted with the fraction of the person's 1935 county in a high-erosion area and medium-erosion area (low-erosion is the omitted category), and controlling for: 1935 county fixed effects, interactions between the "local migrant" indicator and 1935 state fixed effects, and interactions between the "local migrant" indicator and 1935 county characteristics (in 1930, 1925, 1920, 1910).

For these individual-level regressions, robust standard errors clustered by 1935 county are reported in parentheses.

Appendix Table 2. Average Out-selection of Migrants, in the Plains vs. Non-Plains Regions

	Plains Region			Non-Plains Region			
Outcome:	Migrant (1)	Non-Migrant (2)	Difference (1) - (2) (3)	Migrant (4)	Non-Migrant (5)	Difference (4) - (5) (6)	Difference (3) - (6) (7)
Years of Education							
Men	9.73	8.49	1.24	10.32	8.14	2.18	-0.94
	[3.60]	[3.36]	(0.05)	[3.90]	[3.69]	(0.06)	(0.08)
Women	10.21	9.03	1.17	10.51	8.38	2.12	-0.95
	[3.29]	[3.34]	(0.05)	[3.43]	[3.55]	(0.06)	(0.08)
Percent living in	44.80	59.80	-15.01	35.92	59.60	-23.69	8.68
Birht Place in 1935	[49.73]	[49.03]	(0.62)	[47.98]	[49.07]	(1.56)	(1.68)
Percent living on	25.32	37.65	-12.33	10.89	19.77	-8.88	-3.45
a Farm in 1935	[43.48]	[48.45]	(0.90)	[31.16]	[39.83]	(1.16)	(1.47)
Age	40.85	43.85	-3.00	40.79	43.64	-2.85	-0.15
	[8.40]	[8.72]	(0.04)	[8.30]	[8.71]	(0.07)	(0.08)
Percent Male	53.62	49.94	3.68	54.47	50.31	4.68	-1.00
	[49.87]	[50.00]	(0.20)	[49.81]	[50.00]	(0.23)	(0.30)

Notes: As in Table 3, a migrant is someone who lived in different counties in 1935 and 1940 (at least 200 miles apart) and a non-migrant is someone who lived in the same county in 1935 and 1940. For Columns 1 - 3, the sample is people who lived in 1935 within the 843 Plains counties (Figure 1); for Columns 4 - 6, the sample is people who lived outside the 843 Plains counties.

For the indicated outcome variable (in rows): columns 1 and 4 report the sample means for migrants and columns 2 and 5 report the sample means for non-migrants. Column 3 reports the difference between Columns 1 and 2; Column 6 reports the difference between Columns 4 and 5; and Column 7 reports the difference between Columns 3 and 6. Standard deviations are reported in brackets, and robust standard errors clustered by 1935 county are reported in parentheses.