STRUCTURAL CHANGE AND INTERNAL LABOR MIGRATION: EVIDENCE FROM THE GREAT DEPRESSION

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Abstract—We analyze sectoral labor reallocation and the reversal of urbanization in the United States during the Great Depression. The widespread movement to farms, which serves as a form of migratory insurance during the crisis, is largely toward farms with low levels of mechanization. In contrast, the mechanized agricultural sector sheds workers, many of whom reallocate into low-productivity or subsistence farming. The crisis perverts the normal process of structural change in which workers displaced by farm equipment are released into more productive occupations, suggesting that macroeconomic fluctuations are an important factor determining the labor market consequences of technological change.

I. Introduction

THE reallocation of labor across sectors is an important part of economic development and growth. In the case of structural change from agriculture to industry, this process is generally accompanied by both an increase in agricultural productivity and large-scale urbanization as workers leave the agricultural sector and migrate to cities (Lewis, 1954; Ranis & Fei, 1961; Matsuyama, 1992; Gollin, 2010). Periods of economic crisis, however, have witnessed substantial declines in the rate of migration from farms to cities, as well as increases in the rate of so-called reverse migration back to farms. This pattern has been observed during the Great Depression (Spengler, 1936; Thompson, 1937; Boyd, 2002), during the East Asian crisis of the late 1990s (World Bank, 2007; Li, 2009), as well as during the recent financial crisis of 2008–2009 (Kong, Meng, & Zhang, 2010; Huang et al., 2011). The process of structural change is also relevant for advanced economies like the contemporary United States, which in recent decades has suffered large employment declines in routine occupations and in the manufacturing sector. There is evidence that this structural change has contributed to worse labor market performance (Acemoglu, 1999; Delli Gatti et al., 2012; Autor & Dorn, 2013; Charles, Hurst, & Notowidigdo, 2018; Chodorow-Reich & Wieland, 2020; Jaimovich & Siu, 2020).

In this paper, we study the migration between agriculture and the nonfarm sector in the United States during the Great Depression, including the movement out of towns and cities and onto farms, as well as the reallocation of labor within the farm sector. We demonstrate an important relationship between the migration flows and productivity on farms: while the farm sector overall absorbs a large number of in-migrants, the bulk of this movement is to low-productivity farm areas. In fact, mechanized farm areas experience agricultural employment declines and net out-migration during the crisis, with many of their residents moving to lower-quality farms. Figure 1 shows this substantial divergence in population trends during the 1930s between places with the lowest and highest levels of farm mechanization.

Our main empirical strategy makes use of a novel instrument for modernized agricultural production. We show how land topography—specifically the average slope, or *ruggedness*, of the land—influences the suitability for large-scale mechanized agriculture. Farm areas with smoother, less rugged land are more amenable to mechanization and thus exhibit more capital-intensive production. During the crisis, these areas experience relative declines in population and farm employment. We argue that these effects are driven by the characteristics of the farm sector, and we attempt to rule out alternative explanations. We also show that this relationship between ruggedness and farm migration arises only during the severe downturn of the Great Depression, suggesting that the impact of technological change on labor markets depends on broader macroeconomic conditions.[1]

These findings highlight the importance of interactions between short-term macroeconomic fluctuations and the longer-run process of structural change. Instead of releasing labor to the nonfarm sector, as predicted by models of structural transformation, the workers driven off mechanized farms actually reallocate into the lower-productivity subsistence agricultural sector. Thus the "normal" process of sectoral reallocation is obstructed by the crisis. It is not simply that the process slows down or stalls; instead, it takes a perverse form that may actually impede both the economic recovery and the longer-run development process.[2]

Received for publication March 6, 2019. Revision accepted for publication June 3, 2021. Editor: Amit K. Khandelwal.

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We are grateful to Ronald Findlay, Ethan Kaplan, Suresh Naidu, Wolfram Schlenker, and Joseph Stiglitz for their advice and support. Ritam Chaurey, Jonathan Dingel, Jeremiah Dittmar, Ferran Elias, Price Fishback, François Gerard, Allegra Giovine, Bruce Greenwald, Christopher Hanes, Miguel Morin, Jón Steinsson, and seminar participants at Columbia University, Binghamton University, and the 2015 Conference on Large-Scale Crises at Università Politecnica delle Marche provided helpful comments. The editor and three anonymous referees provided comments that substantially improved the paper. We also thank Price Fishback, Michael Haines, and Paul Rhode for kindly providing us with data and Ashwath Chennapan for excellent research assistance.

A supplemental appendix is available online at https://doi.org/10.1162/rest_a_01116.

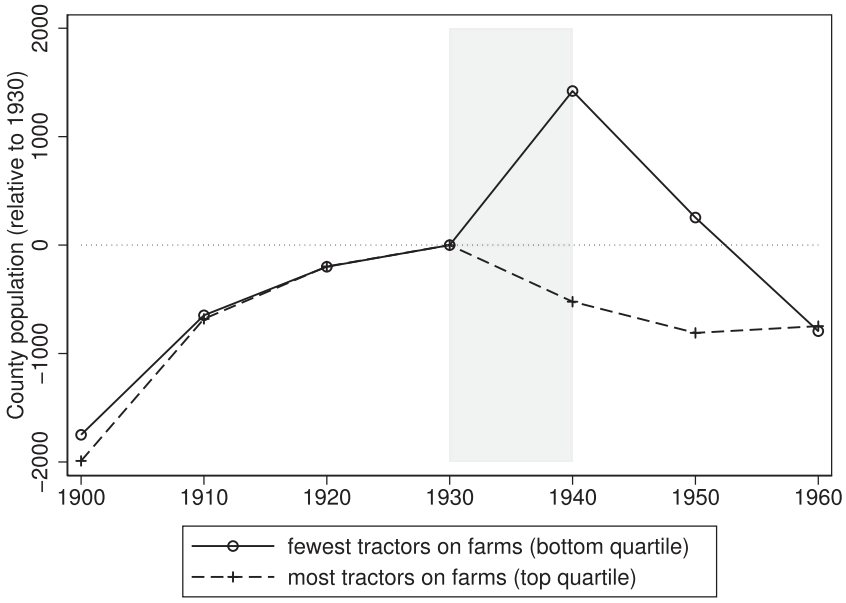
[1] Our finding that the agricultural job losses associated with technological change are concentrated during the initial economic downturn has parallels to the literature studying the more recent effects of technological change, which has demonstrated the importance of economic downturns for the timing of job losses in routine occupations. See Jaimovich and Siu (2020), who document that the longer-term disappearance of routine jobs in the U.S. economy in recent decades is fully accounted for by the job losses that occur during economic downturns.

[2] We view our study of the sectoral reallocation of workers in the farm sector as complementary to the macroeconomics literature examining the relationship between sectoral reallocation and the business cycle. Chodorow-Reich and Wieland (2020) show that sectoral reallocation that takes place

The Review of Economics and Statistics, July 2023, 105(4): 962–981

https://doi.org/10.1162/rest_a_01116

FIGURE 1.—AVERAGE COUNTY-LEVEL POPULATION BY LEAST AND MOST-TRACTOR-INTENSIVE FARM AREAS



The top quartile represents the 25% of rural counties with the highest percentage of farms reporting tractors in 1930; the bottom quartile represents the corresponding least-tractor-intensive counties. Average county-level population for each group is plotted relative to the value in 1930 (by subtracting the 1930 level). The sample is limited to counties reporting no population residing in urban areas in 1930. To get a consistent series over time, counties are adjusted to 1910 county boundaries using area weights. The shaded region indicates the period 1930 to 1940, our main period of interest.

Our results also suggest that the ability to move to farms serves as a source of informal insurance in the early years of the crisis, during a time when formal insurance is not widely available. We confirm the prevailing narrative that the migration to farms is driven at least in part by the crisis in the nonfarm economy. We find that people living in areas hit by more negative shocks to their nonfarm industries are more likely to leave their town or city and move to a farm.[3] By examining data on home production, farm labor, and characteristics of the farm areas, we argue that people are moving to farm areas not because of explicit market-based employment opportunities, but because the farmland offers some other means of subsistence.[4] Taken together, our results suggest that farm mechanization reduces the ability of the land to provide a direct means of basic subsistence, a potentially important source of informal insurance.[5]

Our paper contributes to a number of existing literatures, including the large literature on informal insurance and individual and household coping strategies in response to economic shocks. Klasen and Woolard (2009) look at changes in the dynamics of household formation in response to high unemployment in South Africa. In the United States, Wiemers (2014) examines how individuals use shared living arrangements with family and friends to cope with job loss, and Kaplan (2012) finds that the option to delay leaving home or to move back in with parents serves as an important source of insurance for the young. Yagan (2014) finds large migration responses to labor market shocks.[6] In our case, we observe a large movement into the subsistence farm sector and away from the market-based (farm and nonfarm) sectors.

Our results also add to the literature examining the relationship between the agricultural sector and the Great Depression. Some early analyses of the causes of the Great Depression focused heavily on the shock to agricultural prices (Ohlin, 1931). More recently, Madsen (2001) argues that the

during economic downturns leads to higher unemployment in the local labor market, and Jaimovich and Siu (2020) explicitly argue that the loss of routine jobs during recessions helps explain the subsequent jobless recoveries. These results together imply that the process of structural change in the United States in recent decades—driven in part by productivity increases in manufacturing and in routine occupations—may have macroeconomic consequences by contributing to a weaker national labor market. This argument is explicitly made by Delli Gatti et al. (2012); regarding the Great Depression, they argue that positive productivity shocks in agriculture and interruptions to the process of sectoral reallocation contributed to the depth and persistence of the downturn. Our empirical results for the depression are consistent with the predictions of their theoretical model.

[3]In order to obtain causal impacts of the decline in local-area industrial employment, we construct two instruments based on the initial industrial composition in the county in 1930. See section IVA.

[4]For example, this subsistence value could include shelter, the ability to grow your own food, or informal risk-sharing via family networks.

[5]These findings are consistent with the literature suggesting that exposure to markets and new technologies affects social relations and can erode traditional forms of social protection (Polanyi, 1944; Scott, 1977). While the ruggedness of the land makes it less amenable to modernization in agriculture, it also preserves the ability of these lands to provide a means of subsistence during the downturn.

[6]Gröger and Zylberberg (2016) examine migration patterns among rural households in response to a typhoon in Vietnam and find that households cope by moving to urban areas. We see something of the converse: urban households hit by the downturn cope by moving to rural areas. Rural households also face shocks in our sample, but because of the broader economic downturn, the option of moving to urban areas is less available; instead, there is substantial migration within the rural sector. See Gröger and Zylberberg (2016) and the references therein for a thorough discussion of the literature on household coping strategies in the face of aggregate shocks.

agricultural price decline contributed to the international transmission of the depression, and Hausman, Rhode, and Wieland (2019) show that much of the U.S. recovery in 1933 was attributable to the rise in agricultural prices after leaving the gold standard.[7] Using the case of agriculture in the Great Depression as their guiding example, Delli Gatti et al. (2012) argue that the long-run process of structural transformation can contribute to deep and prolonged economic contractions as a result of barriers to labor mobility across sectors. Our contribution to this literature is twofold. First, we offer evidence of the displacement of agricultural workers as a result of improved productivity on farms, and we show that many of these workers were driven into "nonemployment," by which we mean non-(market-based) employment. Second, we highlight the heterogeneity within the agricultural sector, in the sense that the subsistence agricultural sector should be viewed as significantly distinct from the market-based commercial sector. While a naive reading of the agricultural population data might suggest a relative resurgence of "agriculture" during the depression, we demonstrate how the increase in the agricultural population is in fact consistent with a large negative shock to that sector.[8]

Much of the existing literature on the Great Depression studies the New Deal period beginning after the dramatic downturn; indeed, a number of these papers exploit spatial differences in the intensity of New Deal fund disbursements as a source of identifying variation.[9] In contrast, our paper examines the movement to farms during the economic crisis, most of which occurred during the initial downturn and prior to the introduction of New Deal policies. An important prerequisite for interpreting the findings discussed in earlier papers is to understand how the enormous shock of the downturn affected the distribution of population going into the New Deal. In particular, two implications follow from our results. First, we demonstrate that there were systematic migration patterns occurring between the population censuses of 1930 and 1940, some of which were reversed by 1940. Figure 2 shows, for example, the dramatic rise and fall in the farm population, all of which occurred between 1930 and 1940. This means that we do not have great measures of local population levels within the 1930s, and simply interpolating between the census years is unlikely to provide an accurate measure. Second, because of the nature of this migration—much of which looks like surplus labor in search of subsistence—special care must be taken when using spatial variation across local labor markets to test the effects of policies or study macroeconomic outcomes. We show how unemployment is higher in areas with a greater subsistence value, at least in part because unemployed people are moving there, and thus the local unemployment figures do not necessarily reflect the macroeconomic performance of the local economy.

Finally, we show how the farm migration in the early 1930s varies by race and geography—findings that connect to the literature on black migration in the twentieth century (Gregory, 2006; Wilkerson, 2020). Scholars of the Great Migration of African Americans from the South to the North and West distinguish between a first wave and a second wave, separated by a slowdown during the Great Depression.[10] Despite this slowdown in northward migration, we nonetheless document high levels of movement overall. We find that Black people are more likely to migrate than White people, including moving from cities to farms and from farms to cities. But Black residents of the South are only slightly more likely than their White counterparts to move northward; instead, the bulk of southern Black migration during the depression is toward destinations within the South. In the North, however, many Black people are leaving the region and moving to the South, including to southern farms.

The remainder of the paper proceeds as follows. Section II provides a brief discussion of the historical background. We follow with a description in section III of our data and empirical specifications in section IV and then in section V discuss our main empirical results. Section VI concludes.

II. Agriculture and the Structural Transformation of the U.S. Economy: Historical Background

The settlement of America's West was completed by the turn of the twentieth century. The closing of the frontier meant that the United States could no longer rely on westward

[7] Also see Temin and Wigmore (1990) and Rothermund (2002), and, for a skeptical view, Federico (2005).

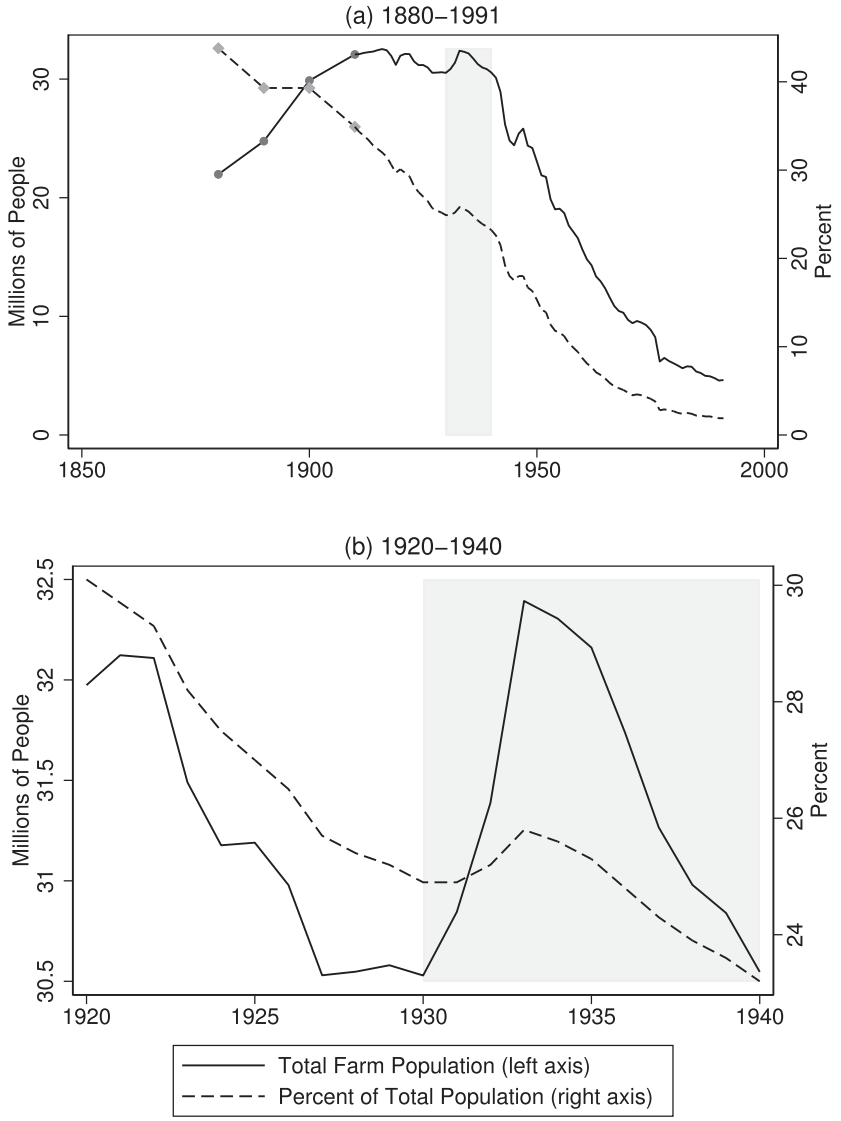
[8] That is, in the aggregate data, the flight to subsistence masks the distress in the market-based agricultural economy. Delli Gatti et al. (2012) also draw explicit comparisons between the decline of agricultural employment in the U.S. economy in the 1920s and 1930s and the much more recent decline in manufacturing employment. Our results suggest that comparisons between agriculture in the depression and the manufacturing sector today should focus explicitly on market-based agriculture.

[9] While the wealth of literature on the Great Depression is vast and impossible to survey here, several papers focused on migration are especially relevant. Boustan, Fishback, and Kantor (2010) note that home economy shocks resulted in out-migration. Using variation in New Deal program generosity and weather shocks, they study the effect of migration on local labor markets. Fishback, Horrace, and Kantor (2006) document a positive in-migration response to New Deal public works and relief grant spending. They also find that payments made to farmers under the Agricultural Adjustment Act (to reduce production) were associated with out-migration on net. On the effects of the AAA, see also Depew, Fishback, and Rhode (2013) and Alston (1981). Long and Siu (2018) study the migration patterns of people displaced by the dust bowl of the 1930s. Like us, they match between the 1930 and 1940 Censuses to examine individual migration during the depression years. But their study is focused on migration in response to a particular shock (the dust bowl), while our paper examines migration patterns in response to the downturn more generally, as well as the relationship to farm technology.

A number of papers also have examined the growth and diffusion of tractors in the first half of the twentieth century. Sorensen, Fishback, and Kantor (2008) study the effects of New Deal programs on tractor adoption in the 1930s. They document an increase in the share of farms owning tractors between 1930 and 1940, from 16.8% to 32.4%. Lafortune, Tessada, and González-Velosa (2015) look at the interaction between migration flows and technological change. They study the effect of immigration flows (and hence, access to labor) on technological choice, organizational form, and output between 1910 and 1940 using data from the Census of Agriculture.

[10] Indeed, in our sample, net northward migration of Black people is low in the early 1930s and turns negative in the late 1930s.

FIGURE 2.—U.S. FARM POPULATION OVER TIME



The figures display the total U.S. farm population over time, and the farm population as a share of total population. Data are available for 1880, 1890, and 1900 and then for each year beginning in 1910. Panel b restricts the series to the years 1920 to 1940. The shaded region indicates the period 1930 to 1940. The farm population reached its peak level in 1916. Source: Series Da1, Da2, Da14, and Da15 from Olmstead and Rhode (2006).

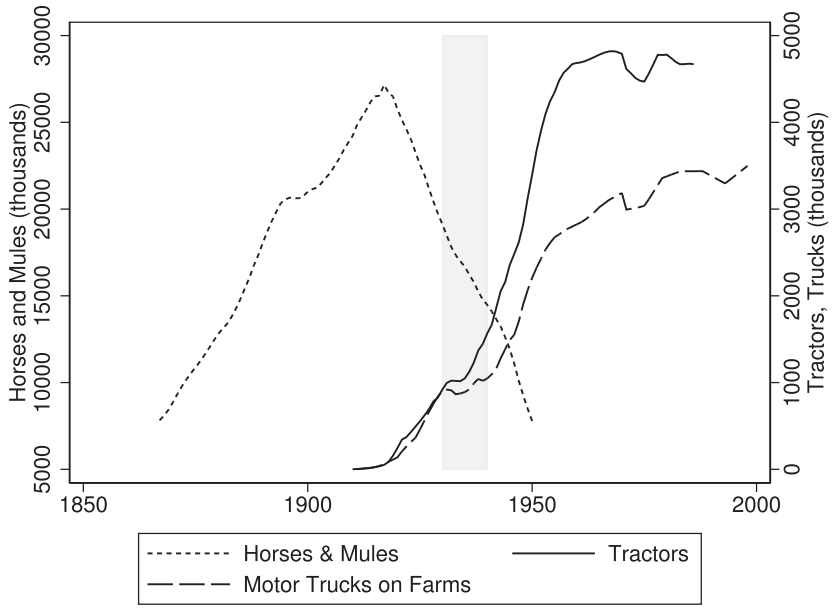
expansion to increase agricultural production or to absorb a growing farm population. Nevertheless, the early twentieth century saw continued increases in the farm population and in the amount of land under cultivation as farmers increased acreage by expanding onto marginal lands. By around 1916, however, the farm population reached its peak; it then declined throughout the 1920s as higher birth rates in farm areas no longer kept up with the increasing rates of farm-to-city migration. The country continued to urbanize, and the farm sector continued to modernize.[11]

[11]This modernization in agriculture was characterized by an expansion over time in the fraction of acreage on large farms, the use of farm machinery, crop specialization, and commercially oriented production (Pettet, 1942; Olmstead & Rhode, 2001; Dimitri, Effland, & Conklin, 2005).

A. *World War I and the "Farm Depression"*

One of the factors influencing these changes was World War I and its effects on agricultural prices. The war caused an increase in demand for U.S. agricultural exports and a big increase in the prices farmers received for their crops. However, the end of the war brought a dramatic decline in agricultural prices. The commodity boom during the war coincided with a boom in land values and mortgage debt (Rajan & Ramcharan, 2015), but after the war, the agricultural sector went through a period of extreme distress—the so-called farm depression of the 1920s. Earlier concerns about the ability of agricultural production to keep up with a growing population (the "food problem") shifted instead toward concerns about the shock to farm incomes and the falling farm population

FIGURE 3.—HORSES AND MULES, TRACTORS, AND MOTOR TRUCKS ON FARMS



This figure displays the total number of horses and mules on farms (left axis) and the number of tractors and motor trucks on farms (right axis). The shaded region indicates the period 1930 to 1940.

(the "farm problem"; see Baker, 1929, and Gray & Baker, 1930). In addition to a decline in farm incomes, this decade witnessed large numbers of farm foreclosures and rural bank failures.[12] Altschul and Strauss (1937, pp. 2–3) attribute what they call the "long-run depression" in agriculture during the 1920s and 1930s to an "accelerated expansion in agricultural production" combined with the "low elasticity of demand for agricultural products."[13] While several factors may have contributed to the farm depression, Altschul and Strauss (1937, 2) argue that "one feature stands out from the rest, namely, rapid mechanization and its consequences."

B. Farm Mechanization

The process of modernization and mechanization in U.S. agriculture had been going on for some time—notably including the introduction and widespread adoption of the reaper in the nineteenth century. But the 1920s witnessed the rapid expansion of several important agricultural technologies, including the motorized tractor, the automobile, the combined harvester-thresher (or combine), and the corn picker (Gardner, 2006). These innovations helped to increase the amount of land that a single worker could cultivate, and they reduced the need for horses and mules as sources of power. As a result, mechanization also served to increase the available farmland: as tractors replaced mules and horses, land that had previously been used for pasture and feed crops was freed up for other uses.[14] By 1930, there were nearly 1 million tractors and another 1 million motor trucks on farms, the vast majority of which had been adopted in the previous ten years. This rapid adoption and its impacts on horses and mules are shown in figure 3.

The effect of mechanization was not uniform across the country, however; it varied by geographic area and by crop. Altschul and Strauss (1937) note that mechanization initially had the greatest impact on wheat production. Even within crops, there was important geographic variation in physical and climatic characteristics affecting the suitability for adoption of different agricultural technologies. The Great Plains region was the most amenable to mechanization due to such characteristics as "wide extremes of temperature, low rainfall, high winds, a loose loam soil, and comparatively large stretches of level land" (U.S. Department of Agriculture, 1932, p. 417)—with sloped land being relatively unsuitable for tractor use. A decade earlier, Baker (1921) had noticed that "the invention and extensive use in the United States of farm machinery, which is constantly becoming more efficient and essential to profitable crop production, has greatly increased the influence of topography in determining the utilization of land"; that is, hilly regions were "poorly adapted to the use of modern farm machinery." More recently, Sorensen et al. (2008) find that the spread of farm tractors in the 1930s

[12] Alston (1983) investigates the farm foreclosures during the 1920s and 1930s and finds a positive association between farm foreclosures and elevated levels of "mortgage debt, depressed farm earnings, and ex post excessive expansion during the World War I agricultural boom," though the latter is not significant in the 1930s.

[13] These same features are key characteristics of the model developed by Delli Gatti et al. (2012).

[14] Citing data from multiple works by O.E. Baker, Altschul, and Strauss (1937) estimate the displacement of horses and mules on farms between 1915 and 1939 resulting from the introduction of the automobile and tractor freed up about 10% of total cropland and pastureland for other uses (corresponding to about 30 million acres of cropland and 31 million acres of pastureland).

was related to a number of soil characteristics as well as the ruggedness of the terrain. We investigate the relationship between farm mechanization and land topography in more detail in section IVB (as well as online appendix D).

C. *The Great Depression*

As shown in figure 2, this process of structural transformation was associated with a decline in the U.S. farm population. During the 1920s, the farm population fell from 32 million at the start of the decade to 30.5 million by 1927 as the growing nonfarm sector absorbed many of the workers no longer needed on farms. With the onset of the Great Depression, however, there was a remarkable reversal. Despite a dramatic fall in farm prices, the farm population *increased* by 2 million people between 1930 and 1933, reaching a level above that at the start of the 1920s. A decade of structural transformation was undone in a three-year period. This population growth was a result of an increase in migration to farms from towns and cities, as well as a sudden stop in the flow of migrants from farms to cities. Thus, it is not just that farm population was increasing due to differentially higher rates of fertility; the years 1931 to 1933 were a period when the net flow to farms was positive.[15]

Economists writing at the time, such as Galbraith and Black (1938), noted this reversal of urbanization as well as an increase in the production of agricultural goods for own consumption.[16] During the "great slide" (Chandler, 1970) or "great contraction" (Friedman & Schwartz, 1965), which lasted from 1929 to 1933, the federal government was reluctant to provide relief to the unemployed, and the relief funds from state and local governments were inadequate for a crisis of such magnitude. Many people instead relied on what Chandler (1970) termed *invisible relief*: "help not from government or organized charity, but from relatives, friends, neighbors, and others" (pp. 51–52). Families "huddled" together and shared resources. Private charities helped some people meet their needs through extra-market means, organizing "give-a-job" campaigns, community gardens, and "arrangements through which the unemployed could barter their services among themselves and for products of nearby farms" (p. 47). The increasing turn toward home production among farm residents, as well as the movement of nonfarm residents to farms, was part of this broader reliance on informal strategies to survive the crisis.

III. Data

We use data from a number of sources, including the population and agricultural censuses, and we create an individual-level data set that links respondents in the 1930 population census to their records in the 1940 Census. As the 1940 Census also contains information on each person's location in 1935, this data set allows us to track people's location and farm status over the course of the Great Depression, from 1930 to 1935 to 1940. We also make use of data from the 1935 U.S. Census of Agriculture, which reported county-level statistics on the number of farm residents in 1935 who had previously lived in a nonfarm residence in 1930, providing an additional independent measure of the migration to farms.

A. *County-Level Data*

Our main sources of data at the county level are the U.S. Population Census and the Census of Agriculture. These data were digitized by Haines and ICPSR (2010) and by Haines, Fishback, and Rhode (2018) and made available on the ICPSR website. We also make use of county-level information on employment, sales, and wages in the retail, wholesale, and manufacturing sectors, originally collected as part of the censuses of manufacturing and distribution, and made available by Fishback and Kantor (2018).[17]

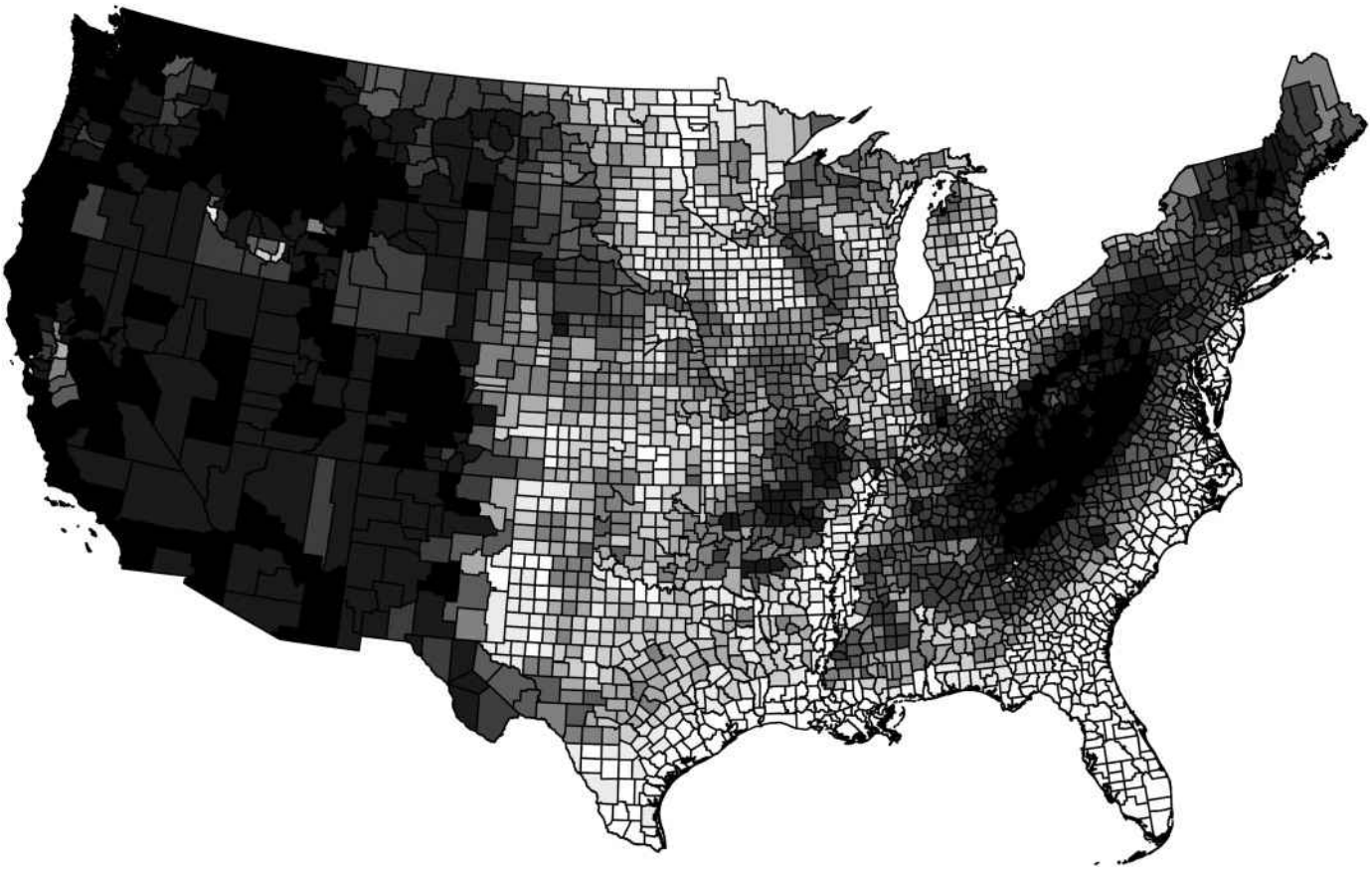
In all, we have information on county-level population every ten years from the decennial census of population for the years 1860 to 1940. We know the population on farms for certain years in which there was an agricultural census, including the decennial census years between 1900 and 1940, as well as for 1925 and 1935. The agricultural censuses also include information on crop production, land values, and farm equipment values. We have some information on farm labor, including cash expenditure on farm labor (for the years 1910, 1920, 1925, and 1930) and number of hired workers (for 1935). We also know the value of farm garden vegetables grown for home use (in 1930 and 1935), which we use as a measure of home production. In addition to data on total population and farm population at the county level, we also have a direct measure of the movement to farms from towns and cities. The 1935 agricultural census reported county-level

[15] See appendix figure A1.

[16] Galbraith and Black (1938, p. 311) write, "It is a matter of common observation that the last depression caused many farmers to increase their reliance upon their own foodstuffs. And the farm population increases more rapidly than usual at such times because of a checking or reversing of the farm-to-city migration." This reverse migration became the subject of commentary by politicians and popular authors at the time, with some advocating for policies to help facilitate such moves. In 1931, Franklin Delano Roosevelt, then governor of New York, gave a radio address in which he asked, "Is it worthwhile for us to make a definite effort to get people in large numbers to move out of cities …? It seems to me that to that question we must answer an emphatic YES" (quoted in Garraty, 1987, p. 199). This goal of resettlement of urban workers into rural areas was not limited to the United States (Garraty, 1987). Brazil removed 40,000 from cities to rural districts in 1930, a similar commission followed in Argentina in 1932. From 1935, France, whose depression started later, began subsidizing rural return. The Canadian government's response to depression included a back-to-the-farm program (Bowen, 1999). The themes around reverse migration are also documented in the literature of the time (Conn, 2009). Ralph Bosordi's book, *Flight from the City* (1933), included how-to chapters on "Domestic Production," "The Loom and the Sewing-Machine," and "Water, Hot Water, and Waste Water." Other writers approached these topics through fiction. The Pulitzer Prize–winning novel *Now in November* (1934), by Josephine Winslow Johnson, tells of a family's return to the countryside following layoffs at a lumber mill.

[17] We use data from the studies by Fishback, Horrace, and Kantor (2005) and Fishback et al. (2011); the original data sources are described in detail in the appendix to Fishback et al. (2011).

FIGURE 4.—COUNTY-LEVEL RUGGEDNESS



Darker color indicates more rugged terrain. The measure of ruggedness is the county-level average gradient or slope (in percent) of the land. See section IIIA for details. Also see appendix figure D2, which displays a map of the residuals from a regression of slope on state fixed effects and better characterizes our identifying variation.

statistics on the number of farm residents in 1935 who had previously lived in a nonfarm residence in 1930, as well as the number of farms reporting at least one such migrant. In addition, the 1930 agricultural census reported similar statistics covering city-to-farm migration in the prior twelve months; in addition to recording farm residents who had moved from towns and cities, the census also asked about farm residents who had left for towns and cities over the same period.

Our main independent variable is a measure of terrain ruggedness from the Digital General Soil Map of the United States, also known as STATSGO2, which contains information on soil characteristics as well as topography derived from a combination of detailed soil survey maps, topographic maps, and remote sensing satellite imagery (USDA Soil Survey Staff, 2016).[18] We use the information on the average slope or gradient of the land (in degrees). We combine the spatially referenced slope information for the contiguous United States with a map of 1930 county boundaries from the NHGIS project (Manson et al., 2018) and compute the spatially weighted average slope for each county. Figure 4 displays a map of the slope values for each county.[19]

Finally, we also use the IPUMS individual-level samples from the 1930 and 1940 population censuses in order to construct county-level characteristics that are unavailable in the county-level files, including measures of the shock to nonfarm employment based on industrial composition.

B. Individual-Level Linked Census Data

To study migration patterns, we also make use of the 100% complete count individual-level data from the U.S. population censuses of 1930 and 1940 (digitized by Ancestry.com and IPUMS).[20] In order to construct a panel data set with information on individuals in 1930 and 1940, we link people

[18] This is (an updated version of) the same data source used by Sorensen et al. (2008) in their study of tractor diffusion. The correlation between our county-level slope measure and theirs is 0.95, and our findings are robust to using their slope measure.

[19] As discussed further in section IVB, our empirical specifications include state fixed effects. In appendix figure D2, we display a map of the residuals from a regression of slope on state fixed effects, which better characterizes our identifying variation.

[20] These data were originally digitized by Ancestry.com and have been made available to researchers as a result of a collaboration between Ancestry.com and IPUMS-USA (Ruggles et al., 2020). These data have restricted access. For the analysis in this paper, we use the data sets deposited at the NBER. See the documentation in the online replication package

between these two census waves. Because the 1940 census includes information on location and farm status in 1935, this linked sample provides information on location and farm status for the years 1930, 1935, and 1940, allowing us to follow individuals over the course of the Great Depression.

Both the 1930 and 1940 data contain information on age, gender, geographic location, place of birth, and farm status, among other characteristics. They also have the individual's first and last names, which were originally written on the census manuscript schedules by the enumerators and then (much more recently) transcribed. For the 1940 Census, the data also contain information on the person's income, occupation, and employment status, as well as information on where the person lived in 1935, including state, county, and farm status.

Unfortunately, these data lack unique identifiers that would allow one to easily match individuals between the 1930 and 1940 data sets (social security numbers, for example). Instead, we need to match individuals based on the characteristics contained in the data. To do this, we use first and last names, age, and state of birth. We only include men in the sample, since women are much more likely to change their names (upon marriage), so we are implicitly matching on gender as well. We do not use a person's current location to find a match, since we are interested in migration patterns and doing so would cause the linked sample to contain a disproportionate number of people who do not migrate.[21]

We use a linked sample where individuals are matched on exact place of birth, exact first and last names, and year of birth within a $+/-3$ year band. First, for the 1930 sample, we drop any duplicate observations, meaning any individuals who share the same names, place of birth, and age. Then, after matching the remaining 1930 observations with potential matches from 1940, we drop any individuals who match with more than one record from 1940. This leaves us with a sample of unique matches only.

We use this conservative matching procedure in order to minimize false positives. One cost is that we are unable to assign matches to the vast majority of individuals. Our final linked data set represents only 15% of the men in the 1930 data set; however, because the data sets are large to begin with, our linked sample is still quite large, containing over 9.3 million people. In the linked sample, the fraction of the population living on farms increases from 25.1% in 1930 to 26.5% in 1935, and then drops back to 22.5% in 1940; these values are very close to the corresponding statistics using the full 1930 and 1940 (unlinked) data sets. This increase in the farm population mid-decade is consistent with the migration patterns discussed above. (Descriptive statistics for the linked sample, as well as for the subset of people living on farms in 1930, are shown in appendix table A1.[22])

We also examine the robustness of our results to alternative linking procedures. Our linking procedure is quite strict: we match on exact names, we include middle names, and we do not standardize common nicknames. To investigate whether these choices influence our results, we obtain data from the Census Linking Project (Abramitzky, Boustan, & Rashid, 2020). These data contain links between the 1930 and 1940 Censuses using four different variations of a linking algorithm, which differ according to how they treat the name cleaning and how strictly observations are determined to be unique.[23] We describe these data further in online appendix C, where we also present tables showing that our results are robust to these alternative choices. As discussed in Abramitzky et al. (2019), there is a trade-off between minimizing false positives (one potential source of bias) and maximizing potential matches (which could affect the representativeness of the sample). While none of these methods is guaranteed to be free of bias, it is reassuring that our results do not depend on the match procedure used.

C. *Individual-Level versus County-Level Data*

We make use of individual-level as well as aggregate population and migration data because each type presents its own advantages and disadvantages. The aggregate data allow us to track county-level population changes but only a single explicit measure of migration—from cities to farms—whereas the individual-level data allow us to track migration patterns in much more detail. On the other hand, the linking procedure used to construct the individual-level data is not perfect. It introduces measurement error (via false links), which could affect the internal validity of our estimates. It also completely excludes women, and it is more likely to include people with unusual names or people born in smaller states, all of which could affect external validity.

In addition, note that we have measures of migration to farms from two completely different original sources—the individual-level data come from the decennial censuses,

as well as https://usa.ipums.org/usa/complete_count.shtml for additional information.

[21] We avoid using race as well, since people may report different races in different years (Nix & Qian, 2015). Other possible variables to match on include mother's and father's birthplace, but unfortunately in 1940, these questions were included in only the long form questionnaires, so the information is available only for 1% of respondents.

[22] We also compute statistics for the fraction of people who change their county of residence, reported in the table as "% migrate." Recall that the 1940 Census includes both 1935 as well as 1940 location, so the migration status between 1935 and 1940 does not rely on the linking procedure, while the 1930–1935 and 1930–1940 variables do. Any incorrect matches (false positives) produced by the linking procedure are very likely to show up as migrants in the sample, since the falsely linked records will often be located in another county. These errors would inflate the migration statistics shown in the table: 33.1% of people are recorded as changing counties between 1930 and 1935, while only 11.9% report changing counties between 1935 and 1940. Some of this difference could indeed reflect higher rates of migration during the first half of the decade, but much of it is likely due to matching errors. (If we were to assume that the true migration rates aren't much different between the two time periods, that would suggest that the false-positive rate for the matching procedure is on the order of 20%.)

[23] These links can be matched to the complete count data sets from IPUMS (Ruggles et al., 2020), which we obtain and use for these robustness checks. The publicly available IPUMS data for 1940 omit the variable for farm status in 1935; we merge in this variable from our 1940 data set.

while the county-level measure comes from the 1935 Census of Agriculture. In general we find consistent results using both measures, which boosts confidence about the quality of the underlying data sets.

IV. Empirical Strategy

This section details our main empirical specifications. First we describe the methods used to examine the effect of the negative shock to nonfarm employment on population and migration, with a particular focus on the movement out of towns and cities and onto farms. The purpose of this analysis is to lend support to the idea that the movement to farms serves as a coping strategy in response to the economic crisis. Then we detail our main empirical strategy, which uses land ruggedness to study the effect of the suitability for mechanized farm production on rural migration.

A. *The Shock to Industry*

In order to study the causal impact of the decline in nonfarm employment opportunities on migration outcomes, we need to isolate exogenous variation in the change in nonfarm employment.[24] We construct two instruments for the size of the nonfarm shock and show that they are strongly related to the local decline in manufacturing employment.[25] Our first instrument exploits the fact that the consumption decline for durable manufactured goods was much greater than for nondurable manufactured goods (Romer, 1990). Rosenbloom and Sundstrom (1999) have demonstrated how this translated into lower employment growth for regions specialized in the production of durables, a result that we confirm using county-level variation. We take as our instrument the percentage of manufacturing employment in the county that is in durable industries in 1930. In a county-level first-stage regression, a 1 standard deviation increase in the percentage of manufacturing workers producing durable goods is associated with a one-third standard deviation decline in manufacturing employment, with an F-statistic on the durables variables greater than 100.[26]

As an additional instrument, we construct the Bartik-predicted change in county-level employment, or the "Bartik shock" (after Bartik, 1991). We weight the national-level employment growth in each industry between 1930 and 1940 by the county-level employment shares in 1930, which gives us a measure of the predicted employment change between 1930 and 1940. The Bartik shock has the advantage that it is constructed using data from all nonfarm sectors, unlike the durables instrument (which is based on manufacturing employment only).[27] However, a disadvantage is that the Bartik shock is constructed using the change in employment over the entire decade, even though we are most interested in the shock during the early crisis years. For this reason, the durables instrument may provide a stronger prediction of the depth of the initial downturn. Because the Bartik shock is a measure of predicted employment growth, here we expect to see a negative relationship with our measures of city-to-farm migration.

We estimate individual-level as well as county-level specifications, with the instruments constructed at the county level. Our specifications are reduced-form equations where we regress the outcome variable directly on one (or both) instruments. (Additional details are provided in online appendix B.) We also show instrumental variables specifications where we instrument the county-level change in log manufacturing employment between 1929 and 1933 with the durables instrument. Doing so reduces the sample size by about one-third (because the intercensal manufacturing employment data are not available for all counties), but it helps with interpreting the magnitude of the effect. For the Bartik instrument, the reduced-form interpretation is clearer, and we do not show IV specifications.

B. *Agricultural Modernization and Farm Migration*

For the second part of our empirical analysis, we study how the characteristics of the local agricultural sector relate to farm in-migration and out-migration. We are concerned in particular with the impact of modern agricultural production technologies. To study this, we develop a novel instrument for the suitability of the land for large-scale mechanized agricultural production: the ruggedness of the terrain, which we measure by the average slope (or gradient) of the land within the county. Table 1 displays the results of a series of first-stage regressions, where we examine the impact of ruggedness on several measures of county-level farm mechanization in 1930. Across each of these measures, ruggedness is strongly and significantly related to farm mechanization: the more rugged the land, the lower the use of equipment and machinery on farms.[28]

We study the effects of farm mechanization by estimating reduced-form specifications of the following form,

$$y_{c,1935} = \delta_r \text{ruggedness}_c + \gamma_s + \mathbf{X}_{c,1930}\Lambda_3 + u_c, \quad (1)$$

[24] One possibility might be to look at the impact of the change in local manufacturing employment, since manufacturing industries are more likely than the retail or wholesale sectors to be producing tradable goods, and thus less likely to be influenced by local demand. However, it is still possible that the employment change in manufacturing is influenced by local economic conditions.

[25] Appendix figure A2 displays the distribution of county-level changes in log manufacturing employment between 1929 and 1933. While virtually all counties witnessed a decline in manufacturing employment during this period, there is substantial variation in the depth of the shock.

[26] Specifically we regress the county-level change in log manufacturing employment between 1929 and 1933 on the durables instrument, controlling for state fixed effects and county total and farm population in 1930.

[27] When we run the same first-stage specification mentioned above—relating the change in manufacturing employment to the Bartik instrument—we find a weaker but still strongly significant relationship. A 1 standard deviation increase in the Bartik-predicted employment growth for 1930 to 1940 is associated with a 0.12 standard deviation increase in manufacturing employment between 1929 and 1933, with an F-statistic of 24.

[28] The first-stage F-statistics are all above 10.

TABLE 1.—RUGGED FARM AREAS HAVE LOWER RATES OF MECHANIZATION

	(1) Log tractors	(2) Log tractors per acre	(3) % farms with tractors	(4) Log equipment value	(5) Log equipment value per acre
Ruggedness	−5.837***	−5.531***	−0.412***	−2.739***	−2.330***
	(1.566)	(1.586)	(0.122)	(0.678)	(0.686)
Observations	2,114	2,114	2,129	2,129	2,129
F-statistic	13.89	12.16	11.41	16.30	11.53
Sample	Rural counties	Rural counties	Rural counties	Rural counties	Rural counties

County-level regressions. The column headings indicate the dependent variable for each specification, representing alternative measures of farm mechanization in 1930. All specifications additionally control for log population and log farm population in 1930, along with state fixed effects. The reported F-statistic is the F-statistic for the ruggedness variable. The sample is restricted to counties with less than 30% of the population living in urban areas in 1930. Robust standard errors in parentheses, adjusted for clustering at the state level. $^{*}p < 0.10$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

where y_c is a measure of farm migration in county c (such as the percent of farms in 1935 containing residents who had been living in towns or cities five years earlier, or the log county farm population in 1935); γ_s is a state fixed effect; and $\mathbf{X}_c$ contains controls for (at minimum) log population and log farm population in 1930. We also estimate individual-level regressions of the following form,

$$y_i = \beta_r \text{ruggedness}_c + \gamma_s + \mathbf{X}_i \Lambda_4 + \nu_i, \quad (2)$$

where y_i is a variable characterizing the migration behavior of individual i—for example, indicating whether their status as a farm resident changed between 1930 and 1935 or whether they moved counties in that time period—and $\mathbf{X}_i$ contains controls for age and age-squared.

Some care must be taken in interpreting our results causally. The use of ruggedness as an instrument helps alleviate some endogeneity concerns, especially those related to reverse causality or certain relatively contemporaneous omitted variables. This could include, for example, cases where the level of local economic development influences farm mechanization or where shocks to a region influence both tractor adoption and the level of nonfarm economic activity.[29] What our instrument does is allow us to isolate the effects of underlying suitability related to farm production.

At the same time, our instrument does not allow us to identify the causal impact of (for example) one more randomly allocated farm tractor, all else equal. Most important, because our measure of ruggedness is time invariant, it ends up being correlated with a number of baseline characteristics. This is to be expected, since mechanization in U.S. agriculture had been going on for some time (including throughout the nineteenth and early twentieth centuries). In this sense, ruggedness is an instrument for the entire package of characteristics that go along with having farmland suitable for mechanized production—something for which there is no perfect measure. To make this point clear, we report reduced-form estimates throughout the paper, as in equations (1) and (2), where we show the direct impact of ruggedness on migration, as opposed to second-stage instrumental variables estimates. In addition, we show that several key characteristics do not vary substantially by ruggedness, which supports our argument that the observed patterns during the depression are related to the downturn; we also show how the patterns during the depression differ from other time periods. Finally, the fact that rugged areas are initially different is part of what makes the observed migration patterns so interesting. For example, these areas have lower land values and lower agricultural output per person precisely because they are less amenable to mechanized farming, and yet we see large inflows of population to these farms. In section VD we examine the threats to the validity of our results and interpretation in further detail.

[29] Suppose that farms that are closer to metropolitan areas have higher levels of mechanization due to better access to capital or product markets; if we see differential outcomes in these areas during the crisis, one should be reluctant to attribute the effects to farm mechanization.

V. Results

A. *Impacts of Nonfarm Employment Shocks on Rural Migration*

We begin by examining the effects of job losses in the nonfarm sector on rural migration, with a special focus on migration from nonfarm to farm residences. Nonfarm residents living in counties facing more severe job losses are more likely to move to a farm residence by 1935. Table 2 displays results using our data set of (male) individuals linked across the population censuses. We construct an indicator variable equal to 1 if the person lived in a nonfarm residence in 1930 and a farm residence in 1935. Columns 1 and 2 restrict the sample to people who lived in nonfarm residences in 1930. An increase of 10 percentage points (about 0.5 standard deviations) in the county-level fraction of manufacturing employment in the (harder-hit) durables sector leads to a 0.55 percentage point increase in the likelihood of a nonfarm resident moving to a farm (column 1). We also control for the percentage of all workers in 1930 working in the manufacturing sector, which ensures that we are identifying only off of the composition of manufacturing employment (durables versus nondurables), and not the initial size of the manufacturing sector. In column 2, we see that a 10 percentage point increase in predicted nonfarm employment growth (about 1.4 standard deviations) reduces the likelihood of moving to a farm by 1.8 percentage points. Since the data set contains information on the individual's own occupation, we can also

TABLE 2.—MOVEMENT TO FARMS VERSUS NONFARM EMPLOYMENT SHOCK

	Move to Farm, 1930–1935			
	(1)	(2)	(3)	(4)
% Mfg in durables, 1930 county	0.0548***			
	(0.0114)			
Bartik, 1930 county		−0.180***		
		(0.0437)		
Works in durable goods sector			0.0207***	0.0171***
			(0.00418)	(0.00295)
% Emp in mfg, 1930 county	−0.219***		−0.213***	
	(0.0321)		(0.0336)	
Observations	5,468,735	5,458,889	5,091,341	634,693
Sample	Nonfarm in 1930	Nonfarm in 1930	1930 nonfarm labor force	1930 mfg workers only

Individual-level regressions. The dependent variable is an indicator for whether the person moves from a nonfarm to farm residence. "Works in durable goods sector" is an individual-level variable; the other independent variables are county-level measures. All specifications include controls for age and age-squared, as well as state fixed effects. Robust standard errors in parentheses, adjusted for clustering at the state level. * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$.

TABLE 3.—FARM MECHANIZATION AND THE MOVEMENT TO FARMS

	% Farms with Movers, 1935		Log Farm Population, 1935	
	(1)	(2)	(3)	(4)
Ruggedness	0.151***	0.140***	0.553***	0.520***
	(0.0356)	(0.0349)	(0.0569)	(0.0535)
% Mfg in durables 1930		0.00898**		0.0184
		(0.00398)		(0.0165)
Bartik 1930–40		0.0182		−0.134***
		(0.0165)		(0.0423)
% Emp in mfg 1930		0.0811***		0.0375
		(0.0250)		(0.0580)
Observations	2,127	1,967	2,127	1,967
Sample	Rural counties	Rural counties	Rural counties	Rural counties

County-level regressions. The dependent variables are the percentage of farms in the county in 1935 reporting at least one person living on the farm who had resided in a nonfarm area five years earlier (columns 1 and 2) and the log of the county-level farm population in 1935 (columns 3 and 4). All specifications include controls for log population and log farm population in 1930, as well as state fixed effects. The sample is restricted to rural counties only, defined as those with less than 30% of the population located in urban areas in 1930. Robust standard errors in parentheses, adjusted for clustering at the state level. * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$.

test whether there is a relationship to actually working in the durable manufacturing sector. We find that being employed in the durable goods sector increases the likelihood of moving to a farm by 2.1% among all nonfarm workers (column 3) and by 1.7% when we restrict to manufacturing workers only (column 4).

The results from county-level specifications are displayed in appendix table B1 and discussed in online appendix B. Our findings are consistent with the explanation that counties facing a larger negative shock to their nonfarm sector see higher levels of migration out of their towns and cities and onto their farms; that is, people are moving within the county from nonfarm residences to farms. Employment losses in nonfarm industries appear to serve as a push factor driving people out of nonfarm areas.

There are several possible explanations for the negative relationship between employment in the nonfarm sector and the growth in the farm population. For example, people could be moving to take jobs in the farm sector, or seeking a place to live, or engaging in subsistence farm production. Among those who move from a nonfarm to farm residence between 1930 and 1935, the fraction residing in their state of birth goes up by 6.5 percentage points, while for all other groups, this fraction decreases over time (appendix tables A16 to A18). This suggests that many of the migrants may be returning to live with (or near) family members.[30] The following sections shed further light on the reasons for this migration and the mechanisms involved.

B. *Agricultural Modernization and Farm Migration*

Rugged areas experience greater in-migration to farms. Table 3 shows the relationship between county-level migration to farms and our instrument for agricultural modernization. The outcome variable in columns 1 and 2 is the percent of farms in the county in 1935 that contain at least one resident who had been living in a nonfarm location five years earlier. There is a positive and statistically significant relationship between the ruggedness of the county and nonfarm-to-farm migration between 1930 and 1935 (column 1). The effect is also large in magnitude: a 10 percentage point increase in the average slope of the county (about 1 standard deviation)

[30] Appendix figures A7 to A10 suggest that these to-farm movers are also more likely to be children, and less likely to be prime age relative to other migrants.

TABLE 4.—FARM MECHANIZATION AND FARM MIGRATION

	Move to Farm, 1930–1935		Moved out of 1930 County			Off-Farm Mover
	(1)	(2)	(3)	(4)	(5)	(6)
Ruggedness	0.122*	0.224***	−0.0679	−0.256***	0.0105	0.00831
	(0.0636)	(0.0745)	(0.0478)	(0.0553)	(0.0635)	(0.0325)
% Mfg in durables 1930	0.0433***	−0.0188	0.00135	−0.00239	0.0118	−0.00571
	(0.0113)	(0.0220)	(0.0195)	(0.00789)	(0.0299)	(0.00506)
Bartik 1930–1940	−0.145***	0.206***	−0.0165	−0.0291	−0.0402	0.0000876
	(0.0441)	(0.0603)	(0.0319)	(0.0176)	(0.0479)	(0.0162)
% Emp in mfg 1930	−0.210***	1.008***	−0.153***	−0.126***	−0.218***	0.184***
	(0.0304)	(0.0885)	(0.0276)	(0.0189)	(0.0320)	(0.0183)
Observations	5,443,474	1,878,279	8,881,460	2,191,071	6,690,387	2,303,357
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Reference Year	1930	1935	1930	1930	1930	1930
Sample	Nonfarm in 1930	On farm in 1935	All males in 1930	On farm in 1930	Nonfarm in 1930	On farm in 1930

Individual-level regressions. The dependent variable is an indicator for whether the person moved from a nonfarm to a farm residence (columns 1 and 2), changed counties (columns 3–5), or moved from a farm to a nonfarm residence (column 6) between 1930 and 1935. The ruggedness measure is based on the person's county of residence in either 1930 or 1935, as indicated by the "Reference Year"; the nonfarm employment variables are based on the 1930 county of residence. The sample is restricted to all men, those on farms only, or those on nonfarm residences only, in the year indicated. All specifications include controls for age and age-squared, as well as state fixed effects. Robust standard errors in parentheses, adjusted for clustering at the state level. $^{*}p < 0.10$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

increases the fraction of farms reporting a to-farm migrant by 1.5 percentage points (about one-fifth of a standard deviation). In order to confirm that this result is not being driven by a correlation between ruggedness and the shock to nonfarm employment, in column 2 we add controls related to the composition of nonfarm employment; these controls include our two instruments for the size of the nonfarm shock, as well as the proportion of total employment in manufacturing. The coefficient on ruggedness remains strongly significant after including these controls and drops only slightly in magnitude. In columns 3 and 4, we display analogous specifications using a different outcome variable: log farm population in 1935. (Recall that all specifications control for the log farm population in 1930, so the regression characterizes the effects on the change in farm population between 1930 and 1935.) There is a large positive effect of ruggedness on the farm population, with a 10 percentage point increase in average slope leading to a 5% increase in the farm population during the first half of the 1930s (which represents more than one-third of a standard deviation of the growth in farm population during that period).[31]

We also confirm these findings using the individual-level data and display the results in table 4. We see a positive relationship between ruggedness of the initial 1930 county and the likelihood of a nonfarm resident migrating to a farm during the crisis (column 1), though the estimate is only marginally significant. The specification in column 2 more closely corresponds to our county-level specifications: we examine the relationship between county-level ruggedness and the likelihood of a 1935 farm resident having previously lived in a nonfarm residence in 1930. Here we see strong evidence that people on farms in rugged areas in 1935 are more likely to have migrated there from a nonfarm residence.[32]

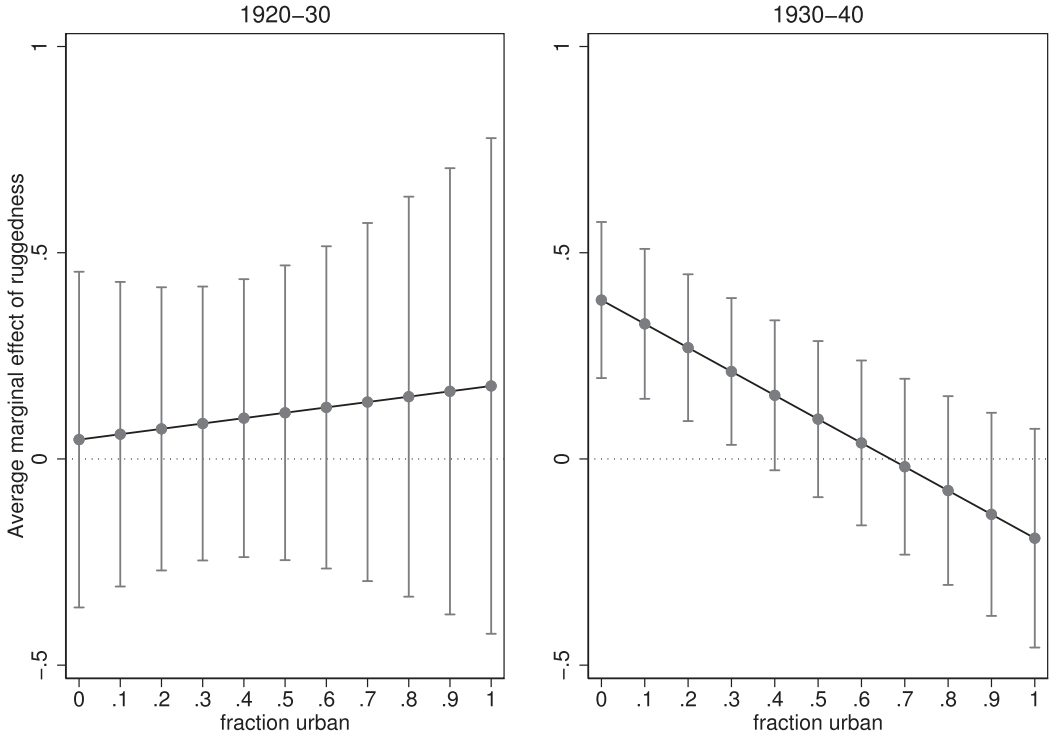
Rugged areas see less out-migration from farms. In addition to the large-scale migration to farms during this time period, there is also substantial movement within the farm sector. Although the national farm population is increasing, more than a third of counties nevertheless witness declines in their farm population between 1930 and 1935 (appendix figure A3). In this section, we examine where people are going—to other farms or to nonfarm residences—and whether this out-migration is related to ruggedness.

In columns 3 to 5 of table 4, we present results using an alternative measure of migration: whether an individual changes counties between 1930 and 1935. On average there is no relationship between county-level ruggedness and out-migration (column 3). Disaggregating by farm status, however, we see that farm residents in rugged counties are far less likely to out-migrate during the crisis than farm residents in less rugged counties (column 4). The point estimate implies that decreasing the ruggedness of the local area by 1 standard deviation—that is, making the land more suitable for large-scale mechanized agriculture—increases the

[31] In appendix table A2, we display the results of instrumental variables regressions, where we instrument the percent of farms reporting tractors in 1930 with the average ruggedness of the land. The results are highly significant. We do not interpret this estimate as the direct effect of tractors per se, since ruggedness affects agriculture and migration in more ways than simply through the prevalence of motorized tractors. Instead, we interpret tractors as a proxy for mechanized agriculture more generally. The estimated magnitudes are useful for interpreting the effects. The point estimate indicates that a 16 percentage point increase in share of farms with tractors (corresponding to 1 standard deviation) results in a 5.8 percentage point decrease (0.9 standard deviations) in the share of farms reporting in-migrants from cities. The table also shows the results of specifications where we use the total value of farm equipment as a proxy for mechanization and instrument this using ruggedness. Again the results are strongly significant and indicate a relative decrease in population on mechanized farms. In appendix table A3, we show that the negative relationship between in-migration and farm productivity holds across a variety of productivity measures: people are moving to places with lower land values, lower values of farm equipment, lower measures of crop suitability, and lower levels of output per farm resident.

[32] The specifications in table 4 include controls for the nonfarm employment variables. In appendix table A4, we display the results of specifications without these controls and continue to see a significant relationship between ruggedness and the movement to farms.

FIGURE 5.—EFFECT OF RUGGEDNESS ON CHANGE IN COUNTY-LEVEL TOTAL POPULATION, BY PERCENT URBAN



This figure displays the estimated marginal effect of ruggedness on (log) total county population by the initial fraction of county population residing in urban areas. The specification in the left panel regresses log county population in 1930 on log population in 1920, county-level ruggedness, the fraction of the county population living in urban areas, and an interaction between ruggedness and urban fraction, in addition to state fixed effects. The specification in the right panel is analogous. Standard errors are adjusted for clustering at the state level, and 95% confidence intervals are displayed. Also see appendix figure A4 for a related (and less parametric) specification.

probability of an existing farm resident out-migrating by 1.9%. For nonfarm residents, however, we see no statistically significant relationship between ruggedness and out-migration (column 5). Notably, we also see no relationship between our two shocks to nonfarm employment and the likelihood that a nonfarm resident moves to another county.

Out-migration from farm areas can take multiple forms: people could be moving to nearby towns and cities, or they could be moving to other farm areas. Column 6 of table 4 indicates that there is no relationship between ruggedness and the likelihood that a farm resident transitions to the nonfarm sector. Thus, the higher rates of out-migration from the relatively more suitable farm areas do not reflect higher rates of urbanization. Instead many of these farm residents are out-migrating toward other farm areas.

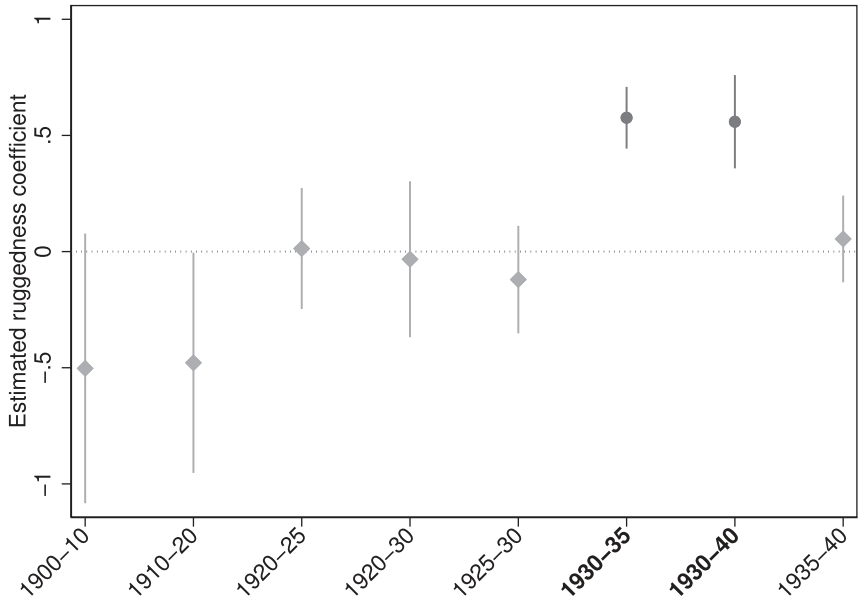
The impacts are driven by the farm sector, and the 1930s are different. To gain a better understanding of the changes in spatial population characteristics, we regress a series of county-level population and employment outcomes on ruggedness and our nonfarm employment measures. (The results are displayed in appendix table A5.) In addition to higher rates of in-migration to their farms and a bigger increase in their farm population, rugged areas also see relative increases in their total population over the 1930s, and this increase is driven entirely by increases in the rural population. Accordingly, rugged counties also see a decline in the percent of the population in urban areas and a rise in the percent on farms. Compared to less rugged areas, these counties are deurbanizing and becoming more agricultural.

Figure 5 presents additional evidence to support our argument that the impact of ruggedness is operating through the farm channel (and not, say, due to a spurious correlation with some feature of the nonfarm economy). The figure shows how the effect of ruggedness on total county population varies with initial percent of the county population living in urban areas.[33] Rural counties see a strong positive relationship between ruggedness and population growth over the 1930s, but this effect is decreasing as percent urban increases. For counties with most of their population living in urban areas, the estimated effect of ruggedness is negative and statistically insignificant. This is consistent with the argument that rugged farm areas are attracting more in-migrants and expelling fewer out-migrants, and perhaps even that people living in cities in more rugged areas are more easily able to move to farms during the crisis.

The left panel of figure 5 shows that the same effect is not present during the 1920s: we see no relationship between ruggedness and county-level population growth and no

[33] Specifically we regress county-level log population in 1940 on log population in 1930, county-level ruggedness, the fraction of the county population living in urban areas, and an interaction between ruggedness and percent urban (in addition to state fixed effects). Also see appendix figure A4 for a less parametric version of this specification.

FIGURE 6.—EFFECT OF RUGGEDNESS ON CHANGE IN COUNTY-LEVEL FARM POPULATION, SELECTED TIME PERIODS



Each marker represents the point estimate from a separate specification. For each period indicated, we regress county-level log farm population in the end year on log farm population in the initial year, log total population in the initial year (for 1925 and 1935, when this is not available, in the previous decennial census year), state fixed effects, and county-level ruggedness. The figure displays the point estimate and 95% confidence interval on ruggedness. Only the periods 1930 to 1935 and 1930 to 1940 show positive and significant effects of ruggedness on county farm population. Standard errors are adjusted for clustering at the state level.

evidence that the impact is larger in rural areas. We also compare the 1930s to earlier time periods by estimating the effect of ruggedness on the change in county-level population for each decade between 1860 and 1940. The point estimates generally indicate that prior to the depression, rugged areas experience relative population decline (and at times the estimate is marginally significant). The only decade between 1860 and 1940 during which there is a positive and significant relationship between population and ruggedness is the 1930s.[34]

We find similar results when we look at the population on farms. Beginning in 1900, we have data on farm population by county, including every five years between 1920 and 1940. In figure 6 we plot the estimated effect of ruggedness on county-level farm population for a number of time periods between 1900 and 1940. In most periods there is no statistically significant relationship between ruggedness and growth in the farm population; the point estimate is near 0 or negative in all time periods except for the 1930s (and negative and marginally significant for the periods 1900 to 1910 and 1910 to 1920). When we examine the effects on farm population in the 1930s, we find a positive and strongly significant impact for the first half of the decade but no significant relationship for the second half.[35] Taken together, these results indicate a substantial change in the relationship between ruggedness and population during the worst years of the depression.

Effects by race. We also examine whether these migration patterns differ according to race.[36] Compared to White residents, Black residents are more likely to engage in each type of migration, including moving to farms, moving off farms, or migrating to a different county. For example, in our linked sample, 18.7% of Black nonfarm residents move to a farm between 1930 and 1935, compared to only 8.3% of White nonfarm residents.[37]

In table 5 we examine the effects of ruggedness separately for Black and White men. While the results are generally similar by race, there are some notable differences. Compared to less rugged farm areas, rugged farms see higher rates of to-farm migration by both White and Black individuals (column 2); ruggedness is also associated with a lower likelihood of out-migration by both White and Black farm residents (column 4). For both specifications, however, the estimated effect of ruggedness is three times greater in magnitude for Black residents compared to White residents, though this difference is only marginally significant ($p = 0.07$) in column 2 and not

[34]These estimates are reported in appendix table A6. In appendix figure A5, we plot these point estimates against the average annual national GDP growth during the corresponding decade. The figure suggests a negative relationship between the effect of ruggedness on population and the health of the overall economy, though the 1930s stands out as an outlier in both dimensions. We adjust for changes in county boundaries over time by spatial averaging the statistics to conform to 1910 counties and weighting by area; we use the correspondences provided by Hornbeck (2010).

[35]We also have county-level data on the movement from cities to farms (and vice versa) between April 1, 1929, and March 31, 1930. For this twelve-month time period, there is no statistically significant relationship between ruggedness and migration. These results are displayed in appendix table A7.

[36]In the full sample for 1930, 88.7% of the population is listed as White and 9.7% are listed as Black. The next largest racial category—Mexican—contains only 1.2% of the population. In this section, we therefore restrict the analysis to White and Black individuals only.

[37]Descriptive statistics are displayed in appendix table A8.

TABLE 5.—FARM MECHANIZATION AND MIGRATION: EFFECTS BY RACE

	Move to Farm, 1930–1935		Moved out of 1930 County			Off-Farm Mover
	(1)	(2)	(3)	(4)	(5)	(6)
A. All Regions						
Black	0.0893***	0.0362*	0.132***	0.138***	0.140***	0.0352***
	(0.00764)	(0.0183)	(0.00918)	(0.0151)	(0.00841)	(0.00422)
Black × Ruggedness	−0.197***	0.679**	0.00257	−0.493**	0.0496	0.0299
	(0.0557)	(0.259)	(0.112)	(0.231)	(0.0923)	(0.108)
White × Ruggedness	0.166**	0.238***	0.000200	−0.138***	0.0572	0.0346
	(0.0681)	(0.0706)	(0.0401)	(0.0311)	(0.0627)	(0.0302)
B. Results by Region						
Black × Non-South	0.0633***	0.311***	0.153***	0.208***	0.148***	0.100***
	(0.00806)	(0.0641)	(0.00943)	(0.0502)	(0.0109)	(0.0198)
Black × South	0.113***	0.0179	0.125***	0.134***	0.140***	0.0298***
	(0.0130)	(0.0169)	(0.0108)	(0.0149)	(0.0124)	(0.00364)
Black × Ruggedness × Non-South	−0.110	0.445	−0.0766	−0.566	−0.0774	0.199
	(0.0787)	(0.471)	(0.184)	(0.509)	(0.191)	(0.181)
Black × Ruggedness × South	−0.166**	0.564**	0.0127	−0.522**	0.141	−0.0234
	(0.0822)	(0.275)	(0.139)	(0.245)	(0.0945)	(0.112)
White × Ruggedness × Non-South	0.0557	0.474***	−0.00589	−0.0496	−0.0121	0.164***
	(0.0744)	(0.102)	(0.0520)	(0.0380)	(0.0749)	(0.0595)
White × Ruggedness × South	0.382***	0.0876	0.00248	−0.189***	0.177***	−0.0409*
	(0.0718)	(0.0842)	(0.0613)	(0.0430)	(0.0628)	(0.0238)
Observations	5,399,129	1,861,759	8,809,898	2,171,168	6,638,728	2,282,155
Nonfarm Controls	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Reference Year	1930	1935	1930	1930	1930	1930
Sample	Nonfarm in 1930	On farm in 1935	All men in 1930	On farm in 1930	Nonfarm in 1930	On farm in 1930

Individual-level regressions. See notes to table 4. "Reference Year" indicates whether the region and ruggedness variables correspond to the county of residence in 1930 or 1935. "Ruggedness" measures the ruggedness of the individual's county in the reference year; "South" and "Non-South" are indicators for whether the individual is located in those regions in the reference year. The sample is restricted to Black and White men. All specifications include controls for age and age-squared, as well as state fixed effects. Nonfarm controls include the percent of county-level manufacturing employment in durables, the Bartik shock, and the percent of employment in manufacturing in 1930. Robust standard errors in parentheses, adjusted for clustering at the state level. $^{*}p < 0.10$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

statistically significant at conventional levels ($p = 0.11$) in column 4. Finally, when we examine the effect of ruggedness of the initial county on the likelihood that nonfarm residents subsequently move to a farm (column 1), we see opposite effects by race: White nonfarm residents living in rugged counties in 1930 are more likely to move to a farm, while Black nonfarm residents in rugged areas are less likely to move to a farm. These results imply that many of the Black men moving to farms are coming from other (less rugged) counties rather than simply moving from a nonfarm to farm residence within the same county.

Because of regional differences in racial population patterns, our estimates by race may be picking up regional differences in migration. We therefore disaggregate these results by region, comparing the South, where 76% of Black men in our sample reside in 1930, to the rest of the country, which we call the non-South or "North."[38] The findings are displayed in panel B of table 5. Column 1 shows that relative to their White counterparts, Black nonfarm residents in both regions are more likely to move to farms. Likewise, Black farm residents in both regions are more likely to move to a different county (columns 3 to 5) and more likely to move from a farm to nonfarm residence (column 6).

In column 2, we see that the effects of ruggedness on the movement to farms differs by race and region. For northern counties in 1935, there is a strong relationship between ruggedness and whether their White farm residents had migrated there from a nonfarm residence, but there is no such relationship for the Black population. In the South, however, we find the opposite results: the effect of ruggedness on to-farm migration shows up only for Black residents. The results in column 4 indicate that the negative effect of ruggedness on out-migration by farm residents is driven by Black farm residents in the South and White farm residents in the North; this effect is not significant for White farm residents in the South and (the small number of) Black farm residents in the North. In contrast to our earlier results, we also see some evidence of a relationship between ruggedness and the likelihood of moving off farms for White men, with a positive relationship for White men in the North and a negative relationship for White men in the South (column 6).

Finally, we also find stark differences by race when we examine the destinations of people who are changing counties or moving to farms.[39] Compared to other groups, the migration pattern of northern Black residents stands out, in that a large portion of these migrants are leaving for the South. Among the northern (i.e., non-southern) Black residents who move to farms between 1930 and 1935, a full two-thirds (67.5%)

[38] In 1930, 10% of Black men in our sample live in the Northeast, 12.8% live in the Midwest, and only 1.2% live in the West. We combine these three regions together for this analysis and slightly abuse terminology by referring to them all as the North.

[39] Descriptive statistics by race and region are displayed in appendix table A9.

are leaving the North to move to a farm in the South. The corresponding figure for northern White residents is only 5.4%. And among southern residents who move to farms, only 4.1% of Black movers and 7.5% of White movers leave the South. We see a similar pattern when we look at the destination of those who change counties between 1930 and 1935. Among all (farm and nonfarm) residents in the North, the fraction of migrants ending up in the South is 44.6% for Black men compared to only 6.1% for White men. For southern residents, only 14% of Black migrants and 17% of White migrants leave for the North. And while Black nonfarm residents in the North were much more likely to move to farms, relative to White nonfarm residents, they were less likely to move to northern farms.[40]

Overall the findings in this section indicate substantial migration to farms among both Black and White people, and both groups are affected by the ruggedness of the land. But there are important regional differences. Most notably, there is no relationship between the ruggedness of northern counties and Black migration. This is partially explained by the low numbers of Black people on farms outside the South: there are very few Black farm residents in the North in 1930, and many of the northern Black people who move to farms between 1930 and 1935 are moving to farms in the South. Among White residents, we find strong effects of ruggedness on farm migration, though the pattern varies by region. Rugged counties in the North attract White farm residents, but not in the South; however, White farm residents living in rugged areas in the South are less likely to out-migrate.

These findings add to our understanding of racial migration patterns during this period. Much of the emphasis in the literature has been on the Great Migration of southern Black people to northern cities, which slowed dramatically during the depression. We find that the slowdown in net Black migration to the North was accompanied by substantial numbers of Black people moving from the North to the South, including many who were leaving northern cities and moving to southern farms. Within the North, the movement to farms was largely a White phenomenon. Black residents in the North were also moving to farms, but for many, that meant leaving for the South. Within the South, however, there was substantial movement to farms, and at least for Black people, a strong relationship between this to-farm migration and the ruggedness of the land.

C. Mechanisms

The results in section VA suggest that the migration to farms is motivated at least in part by the loss of employment opportunities in the nonfarm sector; the ability to move to farms is likely serving as a form of migratory insurance. In this section we further investigate the motivation for migration in the farm sector and in particular the reasons that ruggedness seems to matter so much.

One open question concerns whether rugged farm areas are attracting in-migrants because the opportunities for agricultural employment are relatively better in those areas or whether people are moving there in order to engage in nonmarket or subsistence-type agriculture. From the agricultural censuses of 1930 and 1935, we have information on the value of garden vegetables produced on farms for own consumption, which we use as a measure of home production. The results in table 6 indicate that rugged counties experience larger increases in home production of garden vegetables (columns 1 and 2). We also look at the use of family labor on farms (as opposed to hired labor), which spiked as a share of the agricultural labor force with the onset of the depression (appendix figure A6). Unfortunately there are no county-level data available on the use of family labor in 1930, so we cannot compare the change in family labor over this time period. But we do find that the use of family labor on farms in 1935 is relatively higher in rugged areas (columns 3 and 4). For hired farm labor, we have information for both 1930 and 1935, so we can look at the change over time; the result in column 5 indicates that, controlling for total days of farm labor employed in 1930, there is no significant relationship between ruggedness and the number of people hired to work on farms in 1935. For a small subset of about 400 counties (mostly in the West), we also have information on the number of self-sufficing farms in 1930, and we find that ruggedness is strongly correlated with both the number as well as the share of farms that are self-sufficing (appendix table A11). These results strongly suggest that the relative increase in farm population in rugged areas is not driven by a greater demand for market-based farm labor; instead these areas see higher levels of home production and family-based farm production.[41]

Although we do not observe differential declines in farm labor expenditure between rugged and less rugged areas, it is still the case that less rugged places may be more integrated into the formal economy and thus more affected by the negative shock to markets during the depression. In addition to higher levels of mechanization, less rugged farms are initially larger, employ more hired labor, and produce less output for their own consumption. This higher level of market integration means that even conditional on observable factors like employment and crop mix, the negative shock to agricultural prices during the downturn may have more negative effects on these farms.[42] However, while the less rugged areas have

[40] While the percentage of northern Black residents moving south (17.4%) exceeds the percentage of southern Black residents moving north (9.5%) between 1930 and 1935, the much larger share of Black people living in the South means that in absolute terms, net Black migration is still from the South to the North. But between 1935 and 1940, this reverses: in our sample, the number of Black men moving south exceeds the number moving north during this five-year period.

[41] We also find evidence that places with a higher employment share in durables see relative increases in home production, though the coefficient is significant only in column 1. This result indicates that the shock to market-based work leads people to substitute into home production, which is consistent with the findings of Aguiar, Hurst, and Karabarbounis (2013) for the contemporary United States. We also see a significant relationship in column 4 between the durables share and family labor on farms.

[42] In appendix table A12, we show that the initial level of farm labor expenditure in 1930 is negatively related to the average slope. We also show

TABLE 6.—HOME VEGETABLE GARDEN PRODUCTION AND FAMILY FARM LABOR IN 1935 VERSUS RUGGEDNESS

	Value of Garden Vegetables		Family Labor		Hired Labor
	(1) log total	(2) per farm pop	(3) % farms	(4) % days	(5) log persons
Ruggedness	1.348***	4.468***	0.0459***	0.291***	−0.347
	(0.449)	(1.304)	(0.0118)	(0.0581)	(0.380)
% Mfg in durables 1930	0.153**	0.253	0.00154	0.0198**	0.0120
	(0.0573)	(0.186)	(0.00171)	(0.00761)	(0.0449)
Bartik 1930–1940	0.125	0.833*	−0.000645	0.00241	−0.255
	(0.155)	(0.422)	(0.00704)	(0.0492)	(0.185)
% Emp in mfg 1930	0.844***	1.946**	0.0282**	0.184***	−0.0417
	(0.276)	(0.875)	(0.0109)	(0.0377)	(0.160)
Farms 1930	−0.0716	0.0334	0.00746	0.157**	
	(0.198)	(0.558)	(0.00798)	(0.0611)	
Value garden vegetables 1930	0.456***	1.148***			
	(0.0798)	(0.161)			
Days of farm labor employed 1930					0.585***
					(0.0468)
Observations	1,962	1,964	1,967	1,967	1,967
Sample	Rural counties	Rural counties	Rural counties	Rural counties	Rural counties

County-level regressions. The dependent variables are 1935 values for (1) log of total county-level value (in dollars) of garden vegetables produced on farms for home use; (2) the value of garden vegetable production per 1935 farm persons; (3) the percentage of farms reporting using family labor out of all farms reporting family or hired labor; (4) the percentage of farm labor days by family members out of of total days of (family or hired) farm labor; and (5) the log total number of persons hired to work on farms in the first week of January 1935. All specifications include controls for log population and log farm population in 1930, as well as state fixed effects. Robust standard errors in parentheses, adjusted for clustering at the state level. * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$.

a comparative disadvantage in small-scale production, there is no reason to believe that the farmland in these areas is somehow less suitable for subsistence production in an absolute sense. Nonetheless we see farm residents out-migrating from less rugged areas and far lower rates of in-migration, which suggests that institutions of land ownership are playing a role. Farmers and farmworkers do not simply remain on their farms and engage in subsistence production; instead, they leave. People are moving to rugged areas in greater numbers and engaging in subsistence production because they are more easily able to access those lands and more likely to be excluded from higher-productivity areas.

We look at the relationship between land tenancy and farm migration and find support for this interpretation; these results are displayed in appendix table A13. Tenancy is a pervasive feature of the agricultural labor market at the time. Rather than hire laborers and pay them wages, many landowners rent land to tenants, who pay in cash, or with a share of farm output, or by working on the owner's land. When the crisis hits, areas with a higher prevalence of tenant farms see the lowest levels of to-farm migration and the biggest drops in farm population, as many existing tenants leave (or are forced off) their farms. In contrast, places with many owner-operated farms are more likely to absorb in-migrants (columns 1 and 2) and less likely to see declines in population (column 3). We also see a relationship between migration and tenancy at the individual level. Among farm residents in 1930, those who own their farm residence are much less likely to move out of their county by 1935 (column 5), and they are also less likely to migrate to a nonfarm residence (column 6). We also see that ruggedness has a larger effect on reducing out-migration for tenants than for owners (column 5). These results suggest that the migration patterns are affected by property rights and the consequent impact on access to the land.

that places with higher levels of 1930 farm expenditure see lower rates of nonfarm-to-farm migration and smaller increases in the farm population. In section VD, we show that crop mix does not explain our findings.

D. *Threats to Validity and Alternative Interpretations*

Since ruggedness is not randomly assigned, an important empirical concern is that our estimates are picking up a correlation between ruggedness and some other feature of the economy separate from the impact of ruggedness on the organization of agricultural production. One potential concern is that ruggedness is correlated with the composition or performance of the nonfarm economy, perhaps because terrain can influence the location of business activity or infrastructure. We have discussed several results that help alleviate this concern, including the finding that our estimates of the impact of ruggedness are robust to the inclusion of several control variables related to local employment in the nonfarm sector (tables 3 and 4 and appendix table A5). In addition, the impact of ruggedness is concentrated in rural counties (figure 5).

These findings indicate that the effect of ruggedness is operating through an agriculture-related channel. A remaining concern, however, is that this channel could still be quite different from the mechanisms related to agricultural modernization discussed above. We address three such possibilities—related to climate, crop mix, and farm policies—and display the results in appendix table E1. The depression years are notable for the extremes of temperature and precipitation in much of the country. We therefore include specifications controlling for various weather-related variables intended to capture the county-level exposure to extreme heat, drought, and erosion. Our estimates are very robust to the inclusion of these weather-related controls (columns 2 to 4). Because ruggedness can affect crop choice,

and thus exposure to crop-specific price changes, we include several variables that control for the county-level crop mix (including two separate measures of exposure to the crop price shock, along with the fractions of cropland devoted to wheat and corn). Again the results remain robust to inclusion of the controls (columns 5 to 7). Additional details are provided in online appendix E.

A final concern relates to the agricultural policies that were implemented in response to the Great Depression. Most important, previous research has argued that the Agricultural Adjustment Act (AAA) had an impact on migration patterns (Fishback et al., 2006; Sorensen et al., 2007; Barreca, Fishback, & Kantor, 2011; Depew et al., 2013). In online appendix E, we present several pieces of evidence that indicate that our results do not simply reflect the allocation of government spending, including that much of the migration to farms occurs prior to the introduction of the New Deal programs. We also show specifications controlling for county-level AAA payments in column 8 of appendix table E1, which continue to show a very strong relationship between ruggedness and our migration outcomes, albeit with a substantial decline in magnitude in panel b.

E. Local Labor Markets and "Surplus Labor"

The results above point to a substantial impact of ruggedness on migration flows: rugged areas witness gains in population, driven by gains in the farm areas as a result of higher rates of in-migration and lower rates of out-migration. Given the magnitude of these migration flows, it is possible that there were subsequent impacts on local labor markets. In this section, we investigate the relationship between ruggedness and county-level labor market outcomes and consider whether the findings are consistent with the analysis so far. We look at changes in local area unemployment as well as sales, employment, and wages in the retail, wholesale, and manufacturing sectors.

Across a variety of specifications, we see labor market indicators suggesting that rugged counties perform more poorly during the depression, despite serving as a sink for migration. While there is initially no relationship between ruggedness and county-level unemployment in 1930, we find a strong relationship by 1937: rugged areas have significantly higher levels of unemployment.[43] We find similar results when we examine performance in the nonfarm sectors. Because of the economic crisis, employment and output were falling almost everywhere. But these declines were even larger in more rugged areas, which saw greater declines in aggregate employment in the retail and wholesale sectors, as well as a greater decline in aggregate sales in the wholesale sector.[44] This is despite the fact that these areas experience relative population growth and greater rates of in-migration. At the same time, we find no relationship between ruggedness and performance in the manufacturing sector (which is arguably less dependent on local demand).

These results are consistent with the idea that rugged areas have greater ease of access to the informal migratory insurance provided by available farmland; nonfarm residents in these areas, as well as newly arriving in-migrants, are more likely to engage in subsistence production and thus less likely to engage in market-based consumption or employment.[45] The higher levels of unemployment reflect the fact that unemployed people are choosing to locate in these areas for nonmarket (subsistence) purposes. In addition to providing a way for people to survive the downturn, the farm sector may be absorbing "surplus labor" (Lewis, 1954), especially in the rugged areas where there is easier access to available land.[46]

VI. Conclusion

The relationship between technological change and labor markets has received substantial attention in the academic literature as well as the popular press, but nothing close to a consensus has been reached. There is little question that labor-saving technological change can reduce employment within a particular industry or sector. The relevant debate concerns whether this effect is large enough to have aggregate impacts on wages or employment. Authors who are skeptical that there have been (or will soon be) large negative effects of technology on wages or employment often point out that anxiety over this issue is nothing new. They may even point to the experience of U.S. agriculture as a reassuring example.[47] Indeed the introduction of machinery on farms contributed to a massive shift in the composition of the U.S. workforce over the twentieth century as millions of people transitioned out of agriculture and into the nonfarm sector. Much of this reallocation occurred during the remarkable postwar boom, suggesting that the economy is capable of accommodating a substantial amount of sectoral change while maintaining rapid growth in employment and wages.

But the structural transformation out of agriculture did not begin in 1945. The farm population reached its peak as early as World War I, and the large-scale adoption of motorized tractors began around the same time. In contrast to the postwar experience, evidence from the earlier interwar period is far less reassuring: the first two decades of the "tractorization" of American agriculture coincide with a period of distress for the farm sector. When the entire economy is struck

[43] These results are displayed in appendix table A14.

[44] These results are displayed in appendix table A15.

[45] The results are also reassuring in that they provide further evidence that the relatively greater migration flows to rugged areas are not driven by better economic performance in the nonfarm sectors.

[46] See Schultz (1945, chap. 4) for a discussion of "excess labor in agriculture" during the interwar period.

[47] See, for example, Mishel and Bivens (2017), who point out that the technology-induced "increase in the demand for other goods and services will create jobs to generate those additional goods and services. Where these jobs will appear is unknowable, but history affirms that they do show up. The easiest illustration is what happened to agriculture." And a report from the McKinsey Global Institute points to the rapid decline in the U.S. agricultural employment share and concludes that "the historical record is largely reassuring" (Manyika et al., 2017, p. 4).

by depression in 1929, we see the mechanized agricultural sector shed workers. Many of those workers are not successfully transitioning into the nonfarm economy; instead they are reallocating into a form of nonemployment: subsistence agriculture. Comparing our findings from the Great Depression to the generally more positive experience of the postwar agricultural economy, we might conclude the following: sectors experiencing structural declines in employment will lose jobs in good times and bad, but the state of the macroeconomy influences how quickly and successfully those workers transition into other sectors.

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