NBER WORKING PAPER SERIES

# THE ECONOMIC FOUNDATIONS OF EAST-WEST MIGRATION DURING THE NINETEENTH CENTURY

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Working Paper No. 881

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge MA 02138

April 1982

The author has benefited from comments by Jeremy Atack, Fred Bateman, Stanley Engerman, Robert Fogel, David Galenson, David Haddock, Larry Neal, Edward Ray, James Riley, and workshop participants at the University of Chicago, Harvard University, the University of Illinois, and Indiana University. The research reported here is part of the NBER's research program in Development of the American Economy. Any opinions expressed are those of the author and not those of the National Bureau of Economic Research.

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# The Economic Foundations of East-West Migration During the Nineteenth Century

## ABSTRACT

This paper argues that latitude-specific investments in seeds and human capital provided an incentive for farmers to move along east-west lines. The incentives were greatest during the early and mid 1800s. Towards the end of the century migration patterns changed as farmers learned about farming in different environments, as settlement reached the Great Plains and beyond, and as farming declined in importance. Census manuscript schedules and Mormon family-group records form the basis for empirical work.

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## Introduction

Migration from East to West is a familiar theme in the economic development of the United States during the nineteenth century (Mathews, 1909; Thornthwaite, 1934; Lathrop, 1949; Holbrook, 1950; Clark, 1959; Bogue, 1963; Billington, 1967). After the American Revolution pioneers developed lands west of the Appalachians and during the ensuing decades settlement reached the region of the Mississippi River. By the 1840s many observers argued that the "manifest destiny" of the United States was to occupy and control the territory that lay in the path of settlement to the Pacific Coast.

Although there are many accounts and descriptions of migration during the nineteenth century, the economic incentives behind geographic patterns of migration have been neglected. This paper investigates these incentives. It is argued that latitude specific investments in seeds and human capital induced farmers to move along east-west lines. The incentives were greatest during the early and mid 1800s, and the area between the Appalachians and the Great Plains became stratified by migrants according to their place of birth. The incentives weakened and migration patterns changed towards the end of the century as settlement reached the Great Plains and beyond, as the economy industrialized, and as information about farming in different environments became more readily available. Empirical work is based on samples from the 1860 manuscript schedules of population and Mormon family-group records.

## A Framework for Analyzing Migration Patterns

Migration is an investment that has costs and returns (Schultz, 1961, 1962; Sjaastad, 1962). The money costs include expenditures on food, lodging, and transportation. The non-monetary costs include foregone earnings while traveling, searching for and learning a new job, and the psychic costs of leaving family and friends. The returns include a positive or negative increment to a real earnings stream attributable to a change in earnings; a change in the costs of employment; or a change in prices paid or received by the migrant.

This framework elucidates the stratified pattern of migration observed in the U.S. during the nineteenth century. Factors that influenced the rate of return on this investment are discussed under the headings of seeds, crops, livestock, human comfort and the home economy, and distance.

### Seeds

The photoperiodic adaptation of seeds, especially corn, to a particular latitude probably contributed to east-west migration during the early and mid 1800s. The response of plants to relative lengths of day and night is called photoperiodism (Martin et al., 1976, pp. 44-45; Vince-Prue, 1975). Photoperiodic responses are usually classified on the basis of flowering. Short-day plants only flower or flower most rapidly with fewer than a certain number of hours of light in each 24 hour cycle. Long-day plants only flower or flower most rapidly with more than a certain number of hours of light in each 24 hour cycle. Some plants are day-neutral and flower irrespective of the photoperiodic conditions. For example, small grains (except rice) are long-day plants in which

vegetable growth is stimulated (and flowering is delayed) by the short days of late spring. Corn and rice are short-day plants in which vegetative growth is stimulated (and flowering is delayed) by the long days of early summer; flowering is triggered by the shorter days of summer. Long-day or short-day plants that are grown outside their latitude of adaptation mature too early or too late for optimum performance. Cotton is a day-neutral plant.

The effects of maladaptation on yields are evident from experiments on corn. Fortunately, a variety of experiments were conducted at the Illinois agricultural experiment station during the late 1800s. As a service to the public, the station at Champaign tested the claims of commercial corn seed suppliers (University of Illinois, 1888-1894). From 1888 to 1893 the station acquired seeds that were adapted to about 80 different locations in the Midwest and Northeast. Station personnel grew the seeds under carefully controlled circumstances, and determined yields at an 11 percent moisture content. They acquired some seeds from agricultural experiment stations.

Corn yield per acre was regressed on a second degree polynomial in the distance of the seed source in miles north (+), south (-), east (+), or west (-) of Champaign.[1] The explanatory variables include dummies in crop year that control for variations in weather. The regression also includes a dummy variable in type of seed source because seeds grown at experiment stations may have differed from commercial varieties in their degrees of adaptation to local conditions. The discussions in the experiment station bulletins and the values of the crop year coefficients in

Table 1 indicate that the experiments were conducted under a variety of weather conditions.

The curves in Charts 1 and 2 depict expected yield as a function of distances east or west and north or south of Champaign.[2] Distance north or south sharply reduced yield but distance east or west had relatively little effect. The yields of seeds adapted 250 miles south and 250 miles north were only 62 and 72 percent, respectively, of the yield of seed adapted to Champaign. Yields of seeds adapted up to 250 miles east were slightly higher than those adapted to Champaign, whereas the yield of seeds adapted 250 miles west was 93 percent of the yield of seeds adapted to Champaign.

The photoperiodic response is probably the dominant factor at work in Chart 2. Other features of climate such as temperature or the timing and amount of precipitation may have affected the yields given in Chart 1. Differences in soils between place of adaptation and place of growth probably played a small role (Gooding and Kiesselbach, 1931).

Although the experiments were conducted at one place, it seems clear from the mechanisms at work and from other experimental evidence that the effects depicted in Charts 1 and 2 are relevant to any areas suitable for corn agriculture. The results of experiments conducted at Lincoln, Nebraska during the 1930s are similar to those found at Champaign (Kiesselbach, 1937).

The sensitivity of corn yields of latitude of adaptation affected the rate of return to migration. The first settlers who left a community in search of better agricultural opportunities may have fanned out in various directions. They probably took their own supplies of seed grain,

including corn (Gray, 1932, p. 123; Holbrook, 1950, p. 26; Clark, 1959, p. 214; Boque, 1962, p. 128). Corn was an ideal crop for frontier conditions: it required little seed bed preparation, little cultivation, few tools, and unlike other grains, could be harvested leisurely. Even though principles of photoperiodism were unknown in the nineteenth century, farmers observed its consequences. Farmers who went too far north or south had poor yields, and sent relatively unfavorable reports back to the community from which they left. Thus the reputations of agricultural areas became established and influenced the migration patterns of subsequent settlers. The importance of early settlements in directing later migration is well established (Dunlevy and Gemery, 1977).

Plant adaptation probably had a temporary effect on migration. As settlers acquired knowledge about seeds adapted to different latitudes, seed purchases would have short-circuited the mechanism. Seed distribution by the USDA beginning in the 1860s (Boque, 1963, p. 137) facilitated the movement of migrants to different latitudes. After the mid 1870s state agricultural experiment stations distributed information that made it easier for migrants to farm in a new environment. The earliest settlers, though, may not have had the option to buy seeds adapted to their new locality. Furthermore, the knowledge of adaptation was acquired and diffused over a period of time that may have taken decades. Many factors other than adaptation determined yields, including rainfall, temperature, length of the growing season, planting and cultivating methods, and soil. The type of adaptation discussed here was probably difficult to isolate because it applied only to certain plants, varied across plants that were affected, and applied largely to north-south as opposed to east-west movements. In

addition, the possible role of adaptation may not have occurred to many farmers in the pre-Darwinian era. The fact that the Illinois experiment station conducted experiments on this question as late as the 1890s suggests that an important segment of the farming population lacked reliable information on the effects.

## Crops

Climate, soil, and terrain determined the collection of crops that were grown profitably in a given locality. Given local conditions, farmers acquired skills in an effort to increase yields. They learned, for example, how and when to plow, plant, cultivate, and harvest various crops and how best to cope with the range of local weather conditions. The techniques required to grow profitably the major staples in United States agriculture were widely discussed in the agricultural journals, monographs, and handbooks of the early and mid 1800s. These sources are discussed in Bidwell and Falconer (1925) and Gray (1933). The major agricultural periodicals of the period include The Cultivator, The Prairie Farmer, The American Farmer, The Farmer's Register, The Southern Cultivator, and DeBow's Review.

A farmer contemplating a move sought, other things being equal, a location that maximized the return on previous investments in human capital; namely, a place where the climate, soil, and terrain were familiar. The area from the Appalachians to the Great Plains was subdivided into regions where cotton, tobacco, and grain were profitably grown. While the boundaries of these regions were irregular and there was considerable overlap in some areas, when seen from the perspective of the entire country these regions approximately stratified this part of the United States along east-west

lines. Within these major cropping regions, vegetation and soil strata as well as seed adaptation may have provided additional incentives to migrate within bands of latitude.

Short-staple cotton required at least 200 days between frosts, and therefore was generally not grown north of the piedmont region of North Carolina, parts of Southern Tennessee, and northern Arkansas (Gray, 1933, pp. 888-893). Tobacco can be grown under a wide range of climatic conditions, but the value of the crop depends heavily on the environment where it is grown (Martin et al., 1976, p. 849). During the nineteenth century the most successful tobacco growing areas were in Maryland, Virginia, northern North Carolina, northern Tennessee, Kentucky, southern parts of Ohio, Indiana, and Illinois, and in central Missouri. Wheat can be grown under a variety of climatic conditions, but is poorly adapted to warm or most climates that promote parasitic diseases (Martin et al., 1976, pp. 433-434). During the nineteenth century most of the wheat raised in the U.S. was grown in or north of the border states (Bidwell and Falconer, 1925, pp. 316-338). Corn can be adapted to a wide range of environmental conditions (Martin et al., 1976, p. 326); and during the nineteenth century this crop was widely grown in states east of the Great Plains (Bidwell and Falconer, 1925, pp. 339-349).

Through experience with their native environments, farmers learned to evaluate soils by their color and vegetation that they supported (Hulbert, 1930, pp. 68-82). Black soils, for example, contained a lot of humus and were generally fertile. Red soils were high in iron and usually well-drained. Vegetation was thought to be a more informative guide, however, because it revealed what soils produced under different

climatic conditions. Soils acquired reputations from the trees that they grew, and terms such as "piney soil," "white oak land," and "chestnut oak soil" came into use. Treeless areas such as the "bluegrass" region of Kentucky were characterized by the types of grass vegetation. Whatever the vegetation, thick growth usually indicated good soil, and thin growth poor soil.

Farmers who sought familiar soils and vegetation east of the Great Plains were induced to move within bands of latitude. Zonal soil groups roughly divide the North and the South at the southern edge of the border states (Martin et al., 1976, p. 49). The South is characterized by red and yellow soils, where much of the Northeast and Midwest (except prairie areas) have a grey-brown podzolic (forest) soil.

Similarly, vegetation groups roughly divided the U.S. east of the Great Plains into broad zones that induced migration to the West or the Southwest (United States Department of Agriculture, 1936). Along the southern Atlantic and Gulf plains, longleaf and loblolly pine forest predominated, whereas the upland areas of this region had an oak-pine forest. Much of the land in the border states had a chestnut, chestnut oak, and yellow poplar forest. The Midwest (except for the prairies) was covered with an oak hickory forest, and the northern Great Lakes region had a birch, beech, maple and hemlock forest. Several species of trees imparted a strata within these major forest regions (Preston, 1976). Prairie grasslands dominated much of the landscape west of Indiana.[3]

Livestock

Animals tend to be genetically adapted to a particular climate (Hafex, 1968a,b). Types of adaptation include: (1) Body size and conformation.

Heat loss is a function of body size and surface area. Animals that are suited to cold climates tend to have a large body size with a relatively small surface area, relatively short legs, and small ears; (2) Hair and skin. The skin, subcutaneous tissue, and hair covering control the loss of body heat. Animals that are adapted to cold climates tend to have dark-colored hair, pink or pale skin, thick skin, relatively few sweat glands, thick heavy coats, and a thick layer of subcutaneous fat. Seasonal variations in hair growth (shedding) are under photoperiodic control in horses and cattle. Animal productivity based on milk output, body growth, wool growth among sheep, food consumption and fertility may be adversely affected by maladaptation.

Over a period of weeks or months a given animal may acclimatize to an environment through thermoregulation, body fluid regulation, and cardiovascular regulation (Bianca, 1968; Whittow, 1968a,b; Macfarlane, 1968; Hensel, 1968). Chronic exposure to either heat or cold affects food intake, metabolic rates, hair coat thickness, and weight of internal body organs, the amount of subcutaneous fat, and the composition of body fluids.

During the nineteenth century there was a tendency for regions to specialize in certain types of livestock (Bidwell and Falconer, 1925, p. 387-447; Gray, 1933, pp. 831-857). Oxen and horses have a relatively small surface area relative to weight and were relatively common in the North and border states. Mules are well adapted to warm climates because their long ears and legs expel excess body heat. Southern farmers observed that mules withstood the heat better than horses (Southern Cultivator 11 (July 1843), p. 116; Oliver, 1925, p. 173). Southern observers of the

debate over the best type of draft animal also pointed out that oxen were of limited value in the South because they could not take the heat of late spring and summer (Brooks, 1838, p. 500). Mule production was concentrated in the border states and exports were directed primarily to the South. Sheep and dairy cattle were concentrated in the North and to some extent in the border states. Swine production flourished in Kentucky, Tennessee, and southern Ohio and Indiana.

The regional stratification of livestock types was refined to some extent by specialized breeds. Regional adaptation was accomplished during the Colonial Period by selective retention or disposal of animals according to needs and animal productivity. The number of breeds multiplied rapidly during the antebellum period by importing stock from Europe. Within the North, dairy cattle were particularly well-adapted to the Great Lakes region. Shorthorn cattle thrived in the relatively mild climate of the Ohio Valley. Saxony sheep were small and produced a light fleece and were best suited to the warmer parts of the North. Light saddle horses flourished in the border state climate, whereas heavy draft horses were generally produced and used further north.

Optimal use of livestock types, and to some extent livestock breeds, usually required skills particular to the type or breed. The best methods to raise, train, and care for heavy draft horses, for example, represented a considerable body of knowledge. The best methods to raise, train, and care for livestock types and particular breeds were widely discussed in the agricultural literature cited in the discussion of crops.

Animals were suited or adapted to climate (particularly temperature) zones, and human capital was tied to the animals. Other things being equal,

migrants therefore had an incentive to move within a temperature zone. Except for mountain or coastal areas, temperature zones tended to follow lines of latitude (United States Department of Interior, 1970, pp. 102-111). Mountain and coastal areas, however, absorbed only a small portion of the agricultural population.

## Human Comfort and the Home Economy

People acclimatize to a certain environment over a period of weeks or months (Hirsh, 1941). People accustomed to warm temperatures in the South, for example, have low body-heat production and therefore less energy and less protection against disease when traveling to colder temperatures in the North. Southerners avoided going to far north in part for this reason (Farmer's Register 6 (Dec. 1838), p. 521). People adapted to cold temperatures have high levels of heat production and are uncomfortable at warm temperatures.

People acquired skills that enabled them to live comfortably in a given environment. Settlers often built their own homes and the floor plan, materials, methods of construction, and type of exterior treatment reflected the climate (Pickering, 1951, pp. 19-25). A mild climate encouraged outdoor living and a rambling architectural plan. Log cabins in Tennessee and Georgia, for example, frequently had two single rooms separated by a passage with both units covered by a single roof (Weslager, 1969, p. 72). In Virginia the kitchen was often removed from the house itself. In the North houses were compact rather than rambling, windows were kept small, and usually a single large chimney provided heat.

Other types of latitude specific knowledge contributed to the output of the home economy. Tastes for food and knowledge of recipes depended on the crops that were profitably produced within the region. People who lived south of the border states, for example, made extensive use of corn and corn flour in part because small grains were usually not grown locally. It is clear that methods of preserving and preparing meat were a function of climate (Buley, 1951, pp. 213-215). Before ready-made clothing was generally available in small towns and rural areas, the home manufacture of warm clothes was vital for human comfort in the North.

## Distance

Imagine, temporarily, that the frontier of settlement moved from east to west along a line of longitude. Then if the terrain of the United States was uniform, it would be difficult to establish the arguments advanced so far in this paper versus the hypothesis that farmers moved from east to west merely to minimize the distance traveled to new land. However, the frontier did not move from east to west along a line of longitude and the terrain was not uniform. Kentucky and Tennessee were the first states west of the Appalachians to be settled. By 1815 the region of settlement west of the Appalachians resembled a triangle with points at St. Louis, Pittsburgh, and south-east Tennessee. If distance to new land was the only consideration, then many migrants would have moved north or south out of this triangle. Yet relatively few settlers from the border states ventured north of southern Ohio, Indiana, and Illinois (Mathews, 1909; Billington, 1960;

Boque, 1963); this was despite the fact that low cost water transportation along the Ohio and Mississippi Rivers and their tributaries provided an incentive for people from Kentucky and Tennessee to move into these areas. The 1850 census data on nativity show that migrants from Tennessee avoided states that were substantially outside the path of east-west settlement; only 10 percent of those born in Tennessee but living outside the state resided in Texas, Louisiana, or Iowa (U.S. Census Office, 1853, p. xxxvi). Furthermore, immigrants from Tennessee to Texas preferred the northern part of the state (Lathrop, 1949, p. 35).

The previous discussion does not deny that distance was a relevant consideration in east-west migration. It is clear, however, that distance was not the only consideration.

## Results

One must recognize that many factors other than investments in human capital were involved in the choice of a new living site by an individual or family. The terrain influenced transportation costs and therefore travel routes. The Valley of Virginia and the Ohio River, for example, deflected some migration from the Mid-Atlantic States towards the Southwest. The timing of land surveys, land prices, the threat of Indian attacks, and opportunities to export agricultural surpluses by rail or steamboat were also relevant. While all of these factors may have been exogenous for an individual, some were endogenous when analyzed from the view of the economy as a whole. Land surveys, for example, were influenced by anticipated demand for land, which was a function of the number of potential migrants living to the east. The farmers living in a particular

area probably had similar investments in human capital; if the farmers were sufficiently numerous they may have influenced the course of public policy or the plans of railway or steamboat companies. Investments in human capital were therefore more important determinants of geographic patterns of migration than analysis of the choices facing an individual would suggest.

The analysis suggests several observable implications for behavior; the data available to investigate these implications include local histories, the published census, census manuscript schedules, and Mormon family-group sheets. Local histories and mid-century published census data establish a general east to west settlement pattern (Billington, 1960). Settlers from the Middle Colonies, for example, moved into Kentucky and Tennessee. People from New England, New York and Pennsylvania dominated the settlement of Ohio, while North Carolina, South Carolina and Georgia contributed heavily to the settlement of Alabama and Mississippi.

Stratification of settlement by place of birth is evident within states. New Englanders, for example, settled largely in northern parts of Ohio, Indiana and Illinois and in southern parts of Michigan and Wisconsin (Mathews, 1909). People from Tennessee, Missouri, and Arkansas settled in northeastern Texas (Lathrop, 1949, p. 35). Kentucky, Tennessee, and Virginia settlers predominated in southern Indiana, Illinois, and southeastern Iowa (Boque, 1963, p. 15).

## Manuscript Schedules

The analysis suggests that migration patterns depended on occupation. Other things being equal, farmers had greater incentives than non-farmers

to move within bands of latitude. The population schedules of the census for Illinois in 1860 can be used to test the hypothesis that there was no difference in the migration patterns of farmers and non-farmers. Illinois lay in the paths of settlers from many states and the state therefore is well-suited for testing the hypothesis with census data.

Table 2 sets forth the results of a sample of individuals who resided in 18 Illinois counties in 1860. Among those born out of state but in the U.S., farmers were more likely than non-farmers to reside in a region due west of their state of birth. Generally the non-farmers born in a given region were more dispersed up and down the state than were farmers. The patterns of birth and residence for farmers and non-farmers were significantly different at 0.005.[4]

Although the results for farmers versus non-farmers are consistent with the hypothesis that occupation was a determinant of destination, there was considerable stratification among non-farmers. Among non-farmers one can reject the hypothesis at 0.005 that region of residence in Illinois and region of birth were independent (chi-square = 496.4, d.f. = 12). It should be observed, however, that the category of non-farmers includes occupations such as farm laborers that were tied to farming; thus some of the stratification observed among non-farmers may have been related to the acquisition of agricultural skills. In addition, some children who moved into Illinois as part of a farm family were adults in 1860 who may have chosen non-farm occupations. The first permanent settlers in a region were largely farmers, and migration studies have found (Dunlevy and Gemery, 1977) that later migrants often seek

settlements comprised of people with a cultural background similar to their own. Thus, for example, non-farmers born in New England might have earned equal incomes in northern and southern parts of Illinois, but chose to reside in the northern part because of ties to farmers from New England.

## Family-Group Sheets

The family-group sheets, described in the Appendix, contain information on the county of origin and destination, father's age at the time of the move, and the year of the move. The objects of investigation are the determinants of the extent to which people left or remained in a familiar environment. The dependent variable in the regression analysis is the number of miles moved north (+) or south (+), movement in either of these directions is an approximate measure of the degree of departure from a familiar environment.[5] Although occupation is unknown in these data, the extent of urbanization in the county of destination at the time of the move is a proxy for this variable; the higher the percentage that lived in cities or towns the more likely it was that the migrant had a nonfarm occupation or was leaving agriculture in search of a nonfarm occupation. The expected effect of this variable on the dependent variable is positive.

Farmers who moved from the timberland and prairies onto the Great Plains confronted a new farming environment in which previous investments in human capital were less applicable (Webb, 1931). Furthermore, in the regions of the Rocky Mountains and the Far West relatively more of the labor force was involved in nonfarm occupations such as mining and the fur trade. Moves to or within the West should have been less along lines of latitude than those within the East and the Midwest. An independent

variable representing region of destination within the West is therefore included in the regression. The expected effect of this variable is positive.

Migration to a new farming environment requires investment in new skills. Since the outlays on this investment are concentrated in the early part of the investment period, the net present value of this investment is directly related to the expected length of the payback period. Consequently old compared to young farmers should have been more reluctant to move outside a familiar zone of latitude. Father's age should have a negative effect on the dependent variable.

Migrant farmers probably fanned out from a particular area. Some may have been tempted to go substantially north or south by attractive opportunities in other crops; tobacco and grain farmers who left the Chesapeake area for the cotton lands of the Southwest are an example. Others may have been tempted out of a familiar environment by favorable land prices in a different farming environment or by the attraction of family or friends engaged in nonagricultural pursuits. The predominant pattern, however, was along east-west lines. If the arguments of this paper are correct, then an independent variable that measures miles moved east (+) or west (+) should have a coefficient that is substantially less than 1.

The independent variables also include a polynomial in time. The polynomial may capture fluctuations in transportation costs, variations in land policy, and changes in land prices.

Table 3 gives the estimated relationship. The urban, West, and distance moved east or west variables perform according to expectations. The

father's age variable has the wrong sign and is statistically insignif-icant, possibly because the sample is demographically selective with respect to father's age and the presence of children. Young, unattached men who may have been willing to move to a new agricultural environment are excluded from the sample. The time variables are jointly significant at only .20, which suggests that relevant time related effects have not been excluded from the regression.

The equation in Table 3 was estimated for the time period 1800 to 1874. Estimation by subperiods indicates that the explanatory power of the model declined during the late 1800s. The incentives to move within zones of latitude diminished in the late 1800s as farmers acquired information and seeds relevant to farming in different environments. Furthermore, the percentage of nonfarmers in rural counties probably increased towards the end of the century.

## Conclusions and Suggestions for Further Research

Farmers acquired latitude specific skills in an effort to increase output under local conditions. These investments provided an incentive for farmers to migrate along east-west lines. Farmers who moved too far north or too far south sacrificed crop yields, animal productivity, human comfort, and output in the home economy. The incentives diminished and national migration patterns changed during the late 1800s as farmers learned about farming in different environments, as settlement reached the Great Plains and beyond, and as agriculture declined in importance.

This research has several potential applications. First, much of the continental United States was acquired at a time when incentives to

migrate within zones of latitude were important. The political tensions and negotiations, and the military conflict that were part of this process might be understood better in light of these incentives. Second, migrants take attitudes and ideals from their place of origin and often leave family and friends behind. A stratified migration pattern implies a stratified arrangement of attitudes, ideals, and family ties that may last for years or decades, and vestiges of which may last for generations. This work may contribute to our understanding of the origins of regional differences in voting behavior, educational systems, religion, and forms of local government. Third, the analysis may shed light on geographic patterns of trans-Atlantic migration. It offers, for example, an explanation of why European immigrants avoided the American South.

## FOOTNOTES

1. A separate regression also included variables involving third degree polynomial terms; the coefficients of these variables are jointly significant at only 0.25, which suggests that the second degree formulation is adequate. Distances from Champaign were determined by using latitude and longitude coordinates (United States Department of Interior, 1970) for Champaign and for the town, city, or township where the seed originated. Kirkham (1976) was useful for locating obscure towns.

2. The regression is the source of the curves. The curves give equal weight to each crop year and sample mean weight to the variable Exp. An attempt was made to calculate "equal yield contours" for the yield surface, but the seed source locations are not distributed in a way that provides useful results.

3. The importance of experience with a particular environment is indicated by early settlers who avoided the Midwestern prairies. The great value of the prairies to agriculture is well-known today, but first generation settlers were suspicious of land that grew no timber (Bidwell and Falconer, 1925, pp. 158-159). Their skills were adapted to preparing forest land for agriculture, and wood was the basic ingredient for their houses, furniture, bridges, fencing, farm tools, and fuel. Through experiments conducted on prairie land at the edge of the forest, settlers learned about the productivity of this soil and were then willing to invest in the skills and capital equipment necessary to farm on the prairies (McManis, 1964, pp. 86-88). They learned, for example, to break the tough prairie sod with several yokes of oxen and a heavy plow, to make houses out of sod or bricks, and to make hedges serve as fences.

4. The information in Table 2 constitues a 3-way contingency table in which regions of residence are the rows (R), regions of birth are the columns (C), and occupations are the layers (K). One can reject the hypothesis that the layers of the table are independent given that the rows and columns may be dependent. Chi-square = 122.6 and d.f. = (K-1) (IJ-1) = 20. For a discussion of this test see Fienberg (1977, pp. 24-46) and Upton (1978, pp. 39-45).

5. Distances were measured from county center to county center.

## Appendix: The Family-Group Records

The Genealogical Library in Salt Lake City contains several million family-group records that give the date, county, and state (or country) of birth of the parents and children in a family. A change in the county of birth between successive children implies a migration.

Two samples from the collection comprise the data base for this paper. The first is a sample of 1,682 family-group records, containing 304 moves, drawn as part of the preliminary work on the economics of mortality (The project is discussed in Fogel et al., 1978). A second sample of family group records was selected by stratifying by state and time period in the nineteenth century. Records in the second sample were selected only if they contained at least one migration. Religious motives may have been important in Mormon migration. The pattern of moves to, from, or within Utah was more dispersed and significantly different from the pattern in all other moves. Moves to, from, or within Utah are therefore not considered in this investigation of the non-religious determinants of migration patterns. The combined samples contain 514 moves.

It should be observed that these data differ in certain respects from the population that migrated during the nineteenth century. The data base includes no single individuals and is biased towards large families. Although the family-group records were assembled largely by Mormons during the last 50 years, only a small fraction of their ancestors were Mormons (Fogel et al., 1978, p. 79). Despite attempts to gain representation by region and time period, approximately 65, 16, and 19 percent of the states of origin in the sample are in the North, South, and West, respectively. The corresponding percentages in the population

in 1870 were 64, 30, and 6. The sample contains migrations in every decade of the nineteenth century, but approximately 50 percent of the moves occurred after 1870.

One can correct or adjust for the influence of some deficiencies in the sample. Nevertheless, until more is known about migration patterns contained in the family group records, it is advisable to interpret these data as a special sample that may differ from the population in important ways.

Table 1

Regression of Corn Yield on Seed Source, Crop Year, and Distance of Seed Source in Miles North (+), South (-), East (+), or West (-) of Champaign

| Variable | Coeff. | t-value |
|---|---|---|
| Exp | -.049255 | .0354 |
| YI889 | -9.2131 | 4.93 |
| YI890 | -24.262 | 11.7 |
| YI891 | -22.700 | 10.5 |
| YI892 | -18.262 | 10.3 |
| YI893 | -52.404 | 29.6 |
| NS | -.013599 | 1.36 |
| EW | .0089035 | 2.02 |
| $(NS)^2$ | $-.34021\ (10^{-3})$ | 4.80 |
| $(EW)^2$ | $-.34521\ (10^{-4})$ | 4.48 |
| $(NS)^2(EW)$ | $-.76427\ (10^{-8})$ | .0239 |
| (NS)(EW) | $-.15987\ (10^{-3})$ | 2.18 |
| $(NS)^2(EW)^2$ | $.92735\ (10^{9})$ | 1.18 |
| $(NS)(EW)^2$ | $.12043\ (10^{6})$ | .762 |
| CONSTANT | 86.249 | 55.3 |

$N = 461$, $R^2 = .75$. Dependent variable = bushels of shelled corn per acre; Exp = 1 if seed was from an experiment station, 0 otherwise; Yi = 1 if crop year was i, 0 otherwise, i = 1889,...,1893; EW = seed source in miles east (+) or west (-) of Champaign; NS = seed source in miles north (+) or south (-) of Champaign. Source: University of Illinois, Agricultural Experiment Station Bulletin, "Field Experiments with Corn," Nos. 4, 8, 13, 20, 25, and 31 (Champaign, 1889-1894).

Table 3

Regression of Distance Moved North or South on Percent Urban, Region of Destination, Father's Age, Distance Moved East or West, and Time, 1800-1874

| Variable | Coefficient | t-value |
|---|---|---|
| Percent Urban | .4672 | 2.13 |
| West | 39.62 | 2.82 |
| Father's Age | .09312 | .217 |
| Distance East or West | .1280 | 8.45 |
| Year 1 | 263.8 | 1.66 |
| Year 2 | -90.93 | 1.65 |
| Year 3 | 9.406 | 1.59 |
| Constant | -174.8 | 1.21 |

$R^2$ = .29, N = 261

Definition of Variables: Percent Urban = percent of population in the county of destination that resided in a city or town of size 5,000 or more; West = 1 if the destination was west of the 95th meridian, 0 otherwise; Father's age = father's age at the time of the move; Distance East or West = distance moved east or west in miles; year i = $((\text{year of move}-1779)/20)^i$, i = 1,2,3: Dependent Variable = distance moved north or south in miles.

Source: A sample of family-group sheets, and U.S. Census Office, 1800 (Second) through 1870 (Ninth).

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