U.S. Land Policy, Property Rights, and The Dust Bowl of the 1930s

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"In the morning the dust hung like fog, and the sun was as red as ripe new blood.
All day the dust sifted down from the sky, and the next day it sifted down.
An even blanket covered the earth. It settled on the corn, piled up on the tops of the fence posts,
piled up on the wires; it settled on roofs, blanketed the weeds and trees."
John Steinbeck, The Grapes of Wrath (1939, 6)

I. Introduction.

The process of assigning property rights to land in the American Great Plains resulted in farms that were too small to be economically viable. Under the Homestead Act, hundreds of thousands of 160 to 320-acre farms were founded between 1880 and 1920. These farms were more likely to fail during drought, and because of the cultivation practices used on them, small farms were principal contributors to the region's most significant environmental crisis, the Dust Bowl of the 1930s. Drought conditions returned to the Great Plains in the late 1950s and 1970s, yet there was no return to the Dust Bowl. New farming techniques and larger farms were major reasons.[1]

The path dependence resulting from the initial assignment of property rights on the Great Plains was slow to be corrected. The transactions costs of property rights reallocation from homesteads to larger farms were high, in part due to government intervention. Local politicians sought to retain the dense, Midwest-like population base that homestead settlement had fostered, and they successfully lobbied the Federal Government for subsidies to maintain small family farms. An abrupt loss of rural population was not politically acceptable. The result was a halting process of farm size adjustment between 1920 and 1982. This case illustrates the difficult economic problems that can be raised by an inappropriate assignment of property rights. It cannot be assumed that a more efficient allocation of rights with fewer negative effects will

occur quickly. As Ronald Coase noted, high transactions costs can impede the reallocation process, and as the Dust Bowl indicates, the environmental consequences can be very significant.

II. The Assignment and Reallocation of Property Rights.

One of the most important lessons of Coase's 1960 article, "The Problem of Social Cost," was that the initial assignment of property rights did not matter for efficiency so long as the transactions costs of reallocation were zero. Various examples, such as the problem of damages inflicted by a cattle-raiser on a farmer's fields, were used to show that if property rights could be costlessly traded, then assignment of liability would have no long-run effect on the allocation and use of resources. Coase recognized, however, that if transactions costs were high, then the liability rule or property rights assignment did matter for the overall value of production: "In these conditions the initial delimitation of legal rights does have an effect on the efficiency with which the economic system operates. One arrangement of property rights may bring about a greater value of production than any other."[2] Coase emphasized the transactions costs associated with searching and negotiating exchanges of rights. He did not stress the effects of political intervention that could impede transfers.

Recognizing that transactions costs generally are positive, three issues arise in the assignment of property rights and the internalization of externalities: What process determines the initial rights allocation; what are the social costs associated with the observed assignment; and what transactions costs might limit reallocation toward a more efficient arrangement?

In this paper, we address all three issues by examining American land policy in the late 19th and early 20th centuries as it applied to the Great Plains. We argue that there were powerful political pressures for piecemeal division to meet broad demand for land.[3] Small homesteads of 160 acres were efficiently sized for farming in the central and eastern parts of North America

where rainfall was abundant. But they were not viable for more arid regions. Until the 1920s, however, there was little knowledge of the climate of the Great Plains or of appropriate farm sizes and farming practices for such a region. We examine the political economy of federal land policy to determine why it was not significantly adapted for the more arid conditions.

Second, we examine the social costs of the assignment of property rights to small farmers. By the 1920s, officials of the Agricultural Experiment Stations and Department of Agriculture recognized that small farms were more likely to fail during the droughts that periodically swept the region. We analyze the characteristics of farms that survived the severe 1917-21 drought in the northern Great Plains, using manuscript census data and county directories. Controlling for other factors, small farms were less apt to endure drought. Further, we argue that their cultivation practices during drought contributed to severe wind erosion. Because they were constrained by size, small farmers intensively cultivated their land, did not place portions in fallow, and did not diversify into pasture. Such cultivation made the soil more vulnerable to wind erosion, culminating in the Dust Bowl of the 1930s. The Dust Bowl was one of the most serious environmental disasters in North America in the 20th century, and the small-farm bias U.S. land policy contributed directly to its severity.[4]

The third issue addressed in the paper is the nature of the transactions costs involved in consolidating farms, adjusting the original allocation of property rights toward farm sizes that better reflected the requirements of the region. Although small farms were more likely to fail during any particular drought, the process of consolidation took a long time. To demonstrate the process of property rights adjustment we compare changes in farm size between 1920 and 1987 in the Great Plains region and in the Midwest where small farms were viable. We also include data for a major wheat-growing region of Australia, New South Wales, where the climate was

similar to that in the Great Plains. Changes in the relative prices of labor and capital led to larger farms in all regions. Because farms in the Great Plains started off "too small," more drastic farm size changes were required than took place in the Midwest or in Australia. Yet, politicians resisted the loss of rural population associated with farm consolidation and lobbied for subsidies to maintain the farm population. Small family farmers were an important political constituency.[5] Beginning in the 1930s, the Federal Government provided substantial relief payments to small farms. Although these supplemented farm-based income, they prolonged the operation of inefficient, small farms and delayed the transition to larger units.

II. U.S. Policy for the Assignment of Property Rights to Land.

U.S. land policy began with the Land Ordinances of 1785 and 1787 that called for the orderly, systematic distribution of federal property to private claimants. Survey was to proceed with the delineation of plots within a rectangular grid relative to east-west longitudinal and north-south latitude base lines, with further division into townships of six miles square and 36 sections of 640 acres each. The dominant focus of land policy was on small-farm distribution, as called for by Thomas Jefferson: " The earth is given as a common stock for man to labor and live on...The small landholders are the most precious part of the state."[6] Between 1862 and 1935, when the laws were repealed, the Homestead Acts were the most important policy vehicle. Under the 1862 law, any family head could claim between 40 and 160 acres, and upon 5-years continuous residence and improvement (*cultivation*), receive title.

To understand the political motivation for the piecemeal assignment of property rights in 160-acre plots, the subsequent reluctance of politicians to significantly expand the size of land distributions, and their desire to maintain dense agricultural settlement, we assume that frontier politicians maximized the number of permanent farms in their jurisdiction. This objective

provided a population base supporting the formation of communities, economic development, investment in schools, and greater political influence at the federal level. The link between number of farms and population was through the number of people per farm times the total state or territory agricultural acreage divided by average farm size. Hence, expanding total available agricultural acreage on the frontier through a liberal land policy and keeping individual claims small led to a larger population. Surpassing a population threshold led to statehood with two senators and larger populations, more congressional representatives. Economic development brought political campaign support from constituencies that directly benefited, such as railroad owners and local property investors.

Hence, the objective of a Great Plains politician was to maximize farm population:

$$Max \;\; a\,\frac{L}{s}$$

where α : average number of people per farm
L: total farmland in a jurisdiction
s: average farm size.
Thus, $\frac{L}{s}$ is the number of farms.

Maximizing the farm population, however, was not sufficient for long-term political success and economic development of the region if farms failed due to drought. We assume that farm failure and out migration can be avoided if farm profits are above a minimum critical profit level. Farm failure would occur when:

$$p\left(e(s,f),s,q\right) < \bar{p}$$

or when profit per farm, π, falls below the minimum critical profit level, $\bar{p}$.

Profit, π, is a function of:

ε: randomness associated with rainfall (climatic conditions),
s: farm size,
q: soil quality,
as well as variable inputs, input prices, and price of wheat.

ε is a function of farm size and the proportion of farm size under fallow, *f*. We assume that an increase in farm size allows for greater use of fallow, and that a higher proportion of fallow on a farm and larger farm size reduce the effects of precipitation variation (randomness). Thus,

$$\frac{\partial e}{\partial s} < 0 \; and \; \frac{\partial e}{\partial f} < 0,$$

and $\frac{\partial p}{\partial e} < 0, \frac{\partial p}{\partial s} > 0, \frac{\partial p}{\partial f} > 0$. We also assume that higher soil quality increases profits, $\frac{\partial p}{\partial q} > 0$.

The probability of farm failure, decreases with farm size, fallow share, and soil quality because these factors reduce the effect on yields and profits of precipitation variation. Higher profits per farm make it more likely that the minimum profit level will be met.

The objective of frontier politician, then, is:

$$Max \; a \; \frac{L}{s}\left(1 - prob \; (\; failure \;)\right)$$

where the politician seeks to maximize permanent farm population through programs that reduce the likelihood of farm failure and out migration by meeting or exceeding the minimal profit level.

Until the mid 1920s, knowledge of the weather, effective dry farming techniques and the link between their adoption and farm size, however, did not exist. Accordingly, politicians did not understand the increased survival chances of much larger farms. Absent supplemental income to maintain profits, homesteads might have been rapidly replaced through consolidation. Such a turn of events, however, would have defeated the political objective of maintaining a

large population. By the late 1920s, politicians increasing sought subsidies to sustain small farms:[7]

Thus, adding subsidy in the profit function

$p\left(e(s,\ f), s, q, SUB\right)$ where $\frac{\partial p}{\partial SUB} > 0$ and

$\bar{p} < p\left(e(s,\ f), s, q\right) < p\left(e(s,\ f), s, q, SUB\right)$

Subsidies increased profits and made it more likely that small farms could persist, even in the face of drought.

The homestead allocation of 160-acre plots worked well in northern agriculture, east of the 100th meridian, where there were no important economies of scale in grain production, sufficient rainfall (above 30 inches a year), high soil quality, and familiar conditions, allowing farmers to use knowledge gained in the East or Europe. As migrants moved across the frontier, they transplanted farming practices, crops, and farm sizes used in their places of origin. Under these circumstances, property rights were assigned quickly and agriculture developed rapidly. The objectives of politicians were met. The Midwest was settled successfully with prosperous, small farms; the population of the region grew; railroads were built and communities formed; territories became states; and local politicians became members of the House or Senate and assumed important roles in national politics. George W. Julian of Indiana, for example, who served in the House of Representatives beginning in 1860, became key in shaping federal land policy:

"If our institutions are to be preserved, we must insist upon the policy of small farms, thrifty villages, compact settlements, free schools, and equality of political rights, instead of large estates, slovenly agriculture, wide-scattered settlements, popular ignorance and a pampered aristocracy lording it over the people. This is the overshadowing question of American politics."[8]

By 1880, however, the frontier reached the Great Plains (Figure 1), and conditions were quite different. In his Report on the Arid Lands of North America made to Congress in 1878, John Wesley Powell warned that past methods of agricultural settlement could no longer be relied on and called for a minimum of 2,560-acre homesteads for "pastoral regions." Two bills to change federal land policy were included in his report, but they were not considered.[9] The House Committee on Public Lands did not act on the report. Powell's proposals subsequently were debated in 1879 as part of legislation to consolidate the federal surveys into the U.S. Geological Survey and to create a Public Lands Commission for investigating the need to revise land policy.[10] There was debate in Congress as to whether the remaining portions of federal lands were sufficiently arid to require a revision of the land laws. There was no body of scientific knowledge that supported Powell's claim. Representative Martin Maginnis of Montana asserted that the West would be "one of the Richest and greatest parts of the vast domain of the United States."[11] Representative Thomas Patterson of Colorado emphasized the desire of western representatives to have as much land made available to as many claimants as possible: "Our agricultural lands are limited, and the number of our population following agricultural pursuits must also be limited. But to have that number as great as possible, to swell it to its maximum" the 160-acre homestead must not be exceeded. His fear of "baronial estates" or "land monopolies," was repeated by all opponents of policy change.[12] Powell's suggested minimum distributions were 16 times the size of existing allocations, and the proposals were considered extreme. They would have broken from the past small-homestead policy and drastically reduced the number of farmers that could settle in the region.[13] This policy would have reduced its population and political influence, relative to the Midwest and East. Members of Congress from western states and territories were virtually unanimous in their opposition.[14]

The proposals to consolidate the land surveys and create a Public Lands Commission, however, passed as part of a large appropriations bill, March 3, 1879. Nevertheless, in its 1880 report, the Commission re-emphasized the homestead principle: "The maxim that 'He who tills the soil should own the soil' is accepted as a fundamental principle of political economy. The condition of agricultural industry involved in large holdings with tenant farms is obnoxious alike to the traditions of the people and the principles enunciated by statesmen and publicists. Small holdings distributed severally among the tillers of the soil is believed to be a fundamental condition for the prosperity and happiness of an agricultural population."[15] It made no mention of larger homesteads, although it recommended selling rangeland in large blocks. Congress took no action on the Commission's recommendations, and land policy remained as before. Migration to regions including and beyond the 100th meridian continued, and whereas Kansas, Nebraska, and Colorado had been admitted as states in 1861, 1867, and 1876, in 1889 North and South Dakota, and Montana became states, followed by Wyoming in 1890. Once homesteads were established, small family farmers became an influential constituency that politicians in the Great Plains states sought to protect.

If the objective of politicians were to maximize the number of permanent farms in their states, they might have supported modification of the land laws if there had been a clear understanding that 160-acre homesteads were too small for the Great Plains. But this was not the case. During major migration to the region between 1880 and 1920, there were no long-term weather records to document its limited and fluctuating precipitation. Further, neither the agricultural experiment stations nor the USDA had experience with dry land farming to recommend appropriate agricultural techniques for semi-arid conditions.[16] During wet periods, the Great Plains were extremely productive with high crop yields, and small-farm, eastern

agriculture could be quite successful. During drought, however, yields collapsed, and small farms were at risk. Drawing conclusions about homestead prospects in the region, however, was complicated by the high variability of experiences not only across time, but also across space. Except for a few dramatic cases, droughts tended to be local, so that when farmers in one area were harvesting high yields, those in others might be facing severe shortfalls. Accordingly, prospective migrants could receive mixed claims about the area and be unable to sort whether any failure was due to the weather, poor soil, or poor farming practices.

Absent much understanding of the weather, various doctrines were accepted as ameliorating the problem of potential aridity. One was "rain follows the plow," a notion that rainfall was endogenous with settlement, and through cultivation, precipitation would increase. The other was dryfarming doctrine that asserted that through intensive cultivation of small farms sufficient moisture could be stored in the soil to counter any drought period. Severe droughts in the southern plains in 1893-94 tended to discredit the notion that rainfall was increasing, but dryfarming doctrine remained dominant until the early 1920s.

Under these conditions, hundreds of thousands of migrants moved to the Great Plains to establish small farms. Between 1880 and 1925, 1,078,123 original homestead entries were filed to 202,298,425 acres in western Kansas, Nebraska, and the Dakotas and eastern Colorado and Montana, 45 percent of all homestead filings and 48 percent of all government land claimed during the period.[17] This homestead entry led to the proliferation of small farms in the region.

Table 1 documents the pattern of settlement with mean farm size and percent of farms below 500 acres from 1880 through 1987 for the Great Plains and Midwest. Notice that in the Midwest, homesteading was stable and small farms were viable. There was little change in mean farm size between 1880 and 1950, and small farms below 500 acres accounted for over 90

percent of all farms through 1964. In the Great Plains, homesteading led to an influx of new 160 to 320-acre farms through 1920, with farms under 500 acres accounting for over 70 percent of all farms. The number of farms grew by more than four fold between 1880 and 1920. Beyond 1920, however, mean farm size grew and the portion of farms below 500 acres declined.

With so little climate information about the Great Plains, no past experience with arid lands agriculture, and the objective of politicians to encourage dense, midwestern settlement in the region, there were no imperatives for changes in property rights policy. Other than Powell, there were no advocates for major changes in land laws. A number of small adjustments were made to reflect a growing assessment of the semi-arid conditions of the region, chief of which was the 1909 Enlarged Homestead Act that granted title to 320 acres of land after 5-year's residence *and continuous cultivation*. This beneficial use requirement subsequently would contribute to wind erosion during drought. The law applied to Colorado, Montana, Nevada, Oregon, Utah, Washington, Wyoming, Arizona, and New Mexico. Generally, the other Great Plains states of North and South Dakota, Kansas, and Nebraska were settled under the original 160-acre homestead law.[18]

Analysis of the congressional vote on the Enlarged Homestead Act illustrates the political forces underlying land policy.[19] As in past congressional debates over revising land laws, larger allocations, in this case 640 acres, were rejected as leading to "land monopoly."[20] There were no strong proponents of larger distributions. 320 acres, twice the size of existing homesteads, seemed sufficient for the Great Plains. The proposed change passed 141 to 74 in the House of Representatives, with 172 abstentions on May 11, 1909, and subsequently, became law.[21]

In the Probit analysis, we examine the yes votes, and since there were so many abstentions, we also examine abstentions. As noted earlier, representatives of frontier states

were not convinced that large homesteads were required, and they favored only moderate adjustments in the land laws. Frontier states are indicated by percent change in state population between 1900 and 1910, which was largest on the frontier. Congressional debates do not indicate serious opposition to the proposed doubling of homestead plot size to 320 acres. In other land law debates, representatives of midwestern states had voiced skepticism about the need to open yet more land and greater agricultural production that would depress commodity prices.[22] It is possible that similar concerns existed in 1909. To test for that possibility, the value of corn production by state in 1910 was included. Midwestern states were primarily corn producers, and these were the states where new production might have been of greatest concern. Migration to the frontier also may have attracted labor from manufacturing states and thereby placed some pressure on wages. To test whether representatives of manufacturing states opposed making the frontier more attractive to migrants, we included value of manufacturing by state in 1910. We also added dummy variables for party (Republican).[23]

The estimated equations are:

Yes/ Abstentions = $b + a_1$ population change + a_2 value of corn production + a_3 value of manufacturing + a_4 Republican.[24]

The results are reported in Table 2. Although representatives of frontier states earlier opposed much large allocations of federal land, they were in favor of this limited expansion of homestead plots. The coefficient on the frontier variable, population change, is positive and significant. Frontier representatives also generally were less likely to abstain from voting. Representatives from midwestern states also favored the legislation and did not abstain. Representatives of states that had high values of manufacturing in 1910, largely from the Northeast, however, opposed the legislation or abstained from voting for it.

The results show generally broad western and midwestern support for the slightly liberalized 1909 homestead law. It became the basis for most settlement of the upper Great Plains. In some areas, new homestead settlement led to a decline in average farm size as settlers claimed and subdivided available federal land. For example, in Fergus County, Montana in 1904 prior to major homestead migration there were 472 farm units with average size of 1,300 acres. By 1916 the number of units had grown by nearly ten fold to 4,018, and farm size had fallen to 391 acres, a decline of 70 percent.[25]

III. Small Homestead Farms and Drought.

The distinguishing characteristic of the Great Plains is its aridity and fluctuating rainfall. Severe drought, defined as rainfall on standard deviation below the mean, has no predictable trend. The problem of small farms and drought is repeated throughout the historical and agricultural economics literature after 1920.[26] USDA and Extension Service personnel blamed U.S. land policy for placing hundreds of thousands of small farms on site, and policies to encourage larger farms were urged.[27] For example, the USDA Yearbook of Agriculture (1940, 409) concluded: "The ill-advised application of homestead policies to this territory [Great Plains] divided the land into small units of 320 or 640 acres, where operating units of several sections [1,280-1,920 acres] were requisite."

There were numerous problems with small homesteads. One was that because of their limited size, it was impractical to diversify from wheat into livestock. Cattle were attractive because they could be raised even when wheat yields were low, and real wheat and cattle prices were not correlated (.09). Maintaining some livestock could be a means of smoothing incomes.[28] Further because of grass cover, pastureland was much less vulnerable to wind erosion during

drought. In contrast, because they were intensely cultivated, small farms increased the risk of wind erosion.

Under wet conditions and high wheat yields, a small enterprise could produce enough to sustain a family by placing the entire farm in crops. Returns were comparable to mean farm earnings elsewhere in the country. Continuous cropping, however, resulted in the land being plowed and cultivated throughout the year without the use of fallow. Fallow was a practice of idling half of a farm each year with protective mulch to collect moisture and nutrients. But only larger farms could afford to keep so much land out of production. Strip cropping (alternating bands of fallow and crop) and other practices designed to mitigate drought and protect soil against wind were not feasible.[29] As a result, drought was much more devastating to homesteads than to other farms. Loan foreclosures and farm abandonment were much higher for homesteads than for larger farms in the Great Plains.[30]

County Directories show the effect of drought on small homesteads. Directories for Cascade and Fergus County, Montana in the early part of the twentieth century provide lists of farms by size. In 1916, at the peak of homesteading, there were 3,960 farms in Fergus County and 2,193 in Cascade County. A severe drought, however, hit the northern plains between 1917 and 1921, and many farms failed. As shown in Table 3, larger farms were more apt to survive. In Fergus County 32 percent of the farms survived to 1922, and these farms were about 30 percent larger in 1916 than were those that failed. Only 14 percent of the farms in existence in 1916 were listed in the directory in 1930, and those farms also were larger in 1916 than were those that failed.[31] Similarly in Cascade County, 33 percent of the farms survived to 1923, and they were about 22 percent larger than non–survivors. Farms that were larger in 1916 also were more likely to endure through the decade.

Additionally, one of the few surviving agricultural census manuscript records for 1920 includes Carbon County, Montana, an area partially in the Great Plains. We also have County Directory data that list farmers and farm sizes. Comparing the 1916 and 1919 and 1922 Carbon County Directories allow us to identify which farmers were in residence in 1916 and 1919 to be matched with the census data and to determine who survived the drought through 1922.[32]

Using the 1916 and 1919 county directories, we identified 726 farmers who were in Carbon County in both years. Many were homesteaders.[33] The 1922 directory shows that 299 survived the drought, giving an overall survival rate of 42 percent. Using the names from the 1916 and 1919 directories and matching them with those in the 1919 census manuscript provides a sample of 138 farmers. Of those 138 farmers, 68 survived to 1922, for a survival rate of 49 percent, slightly better than the total sample, and 70 were non-survivors.[34]

With these data we can isolate the characteristics of successful farms.[35] For the statistical analysis of survivors and non-survivors, we removed farmers who had holdings of less than 80 acres, untypical of dryfarming regions, and who were 65 years or older.[36] This left a sample of 109 farmers, with 61 surviving through 1922. The census data include age, employment history, farm size, crop and pasture land, asset value, crops and livestock, and products sold.

Survival = f(location dummies, farmer age, total crop acres, total pasture acres, farm value per acre, value of livestock, value of wheat sales).

Farmer age is a proxy for experience.[37] Total crop acres are derived from the census data for crop acres harvested, crop acres failed, and crop acres fallow or idle. This is the key farm size variable. In Carbon County, farms were divided into crops and pasture, with the best lands for crops and the least productive for pasture.[38] The county was not an important livestock-producing area. Hence, total crop acres reflect the size and potential productiveness of the farm. Total pasture indicates less productive land, with a negative effect on survival. Farm value/acre is farm value as listed in the census /total farm size.[39]The variable declines with farm size and should be negatively related to survival. Livestock value included the value of cattle, dairy cattle, sheep, hogs, and poultry, and is a proxy for livestock sales to test for the effects of diversification from wheat.[40] The value of wheat sold is total wheat bushels sold times wheat prices received by farmers in 1919 per bushel.[41] This income variable examines the effect of the size of wheat earnings on survival.[42]

The results of the probit analysis are shown in Table 4. As shown in the table, farmer age is an important factor in farm survival. The major farm size variable, total crop acres contributed to survival, while pasture acreage did not. Both the values of wheat sales and livestock have a positive effect, but only livestock is significant at the 10 percent level. The other financial

variable, farm value per acre, has a negative coefficient and is significant at 5 percent level. Farm value per acre decreased with size and larger farms tended to survive.

Mean farm size for the 61 surviving farms was 157 crop acres and 375 total acres, whereas for the 48 non-surviving farms, it was 129 crop acres and 331 total acres. Survivors then were about 18 percent larger in terms of crop acres and 12 percent larger for total acres than those farms that failed. Surviving farms were not only larger, but they were more diversified into livestock. The mean value of livestock for survivors was $1,906, more than double the mean of $817 for non-survivors. Wheat sales also were higher for survivors at $277 on average, compared to $189 for non-survivors.

A farm with the mean sample characteristics had a 61 percent chance of survival. Increasing total crop acres by one standard deviation raises the probability of survival to 72 percent, and if the value of wheat sales also is increased by one standard deviation, the probability of survival rises to 80 percent. These results underscore the general observation that larger farms were more likely to survive the drought.

The agricultural economics literature in the 1930s stressed size as the key factor in enduring drought. For example, Renne (1936b, 4) criticized the Homestead Acts for leading to the proliferation of small uneconomical holdings in the northern plains. In commenting on drought and farm failure on the Great Plains, Johnson (1937, 153, 162) cited the problem of homesteads. Starch (1939, 119) argued that farms had to be diversified into wheat and livestock to withstand dry periods, but noted that sufficient livestock were not possible on small units. Clawson, Saunderson and Johnson (1940, 34) pointed to widespread loan foreclosures and the subsequent abandonment of small farms. Huffman and Paschal (1942, 17) claimed that even in 1942: “Many operators still are trying to farm land unsuited to cultivation. Their units are too

small and they have little security against drought."

IV. Small Farms and the Dust Bowl.

The Dust Bowl was certainly one of the major environmental crises of the twentieth century in North America.[43] Intense wind erosion began in the northern plains in 1931 and moved to the south and lasted through 1940. 1938 was the peak year. The storms were huge, some 600 by 400 miles, lasting 10 hours or more. One dust storm in May 1934 started in Montana and spread south, carrying some 350 million tons of soil toward the East Coast. During a storm of February 7, 1937, 34.2 tons of soil fell per square mile at Ames, Iowa, 14.9 tons at Marquette Michigan, and 10 tons across the continent in New Hampshire.[44] Johnson (1947, 194-5) estimated that in 1935 alone 850 million tons of topsoil had blown away from 4,340,000 acres in the southern plains.

By 1935, 65 percent of the total area of the Great Plains had been damaged by wind erosion, with 15 percent severely affected. Erosion was greatest in Oklahoma, impacting over 70 percent of the land, with 18 percent of Texas, 25 percent of Colorado, 16 percent of New Mexico, 30 percent of Kansas, and 17 percent of North Dakota damaged.[45] By 1938, the Soil Conservation Service estimated that 80 percent of the land in the southern plains had been subject to wind erosion, with 40 percent to a serious degree. 10,000,000 acres had lost the upper five inches of topsoil, and 13,500,000 acres had lost 2 1/2 inches, with an average loss of 480 tons of topsoil per acre. Dust smothered adjacent range and crop land.[46]

Because light, rich topsoil was most likely to be carried away, leaving sandy infertile soil behind, wind erosion depleted soil quality and productivity. Damaged areas required the addition of fertilizers and organic material to reconstruct soil productivity. Samples of soil carried 500 miles from Texas to Iowa had 10 times as much organic matter, 9 times as much

nitrogen, 19 times as much phosphoric acid, and 45 percent more potash as compared to the soil that remained.[47]

The Great Plains is a transitional climatic region most often affected by drought and has the continent's strongest winds. Under normal conditions of ground cover, wind erosion is a normal geologic process, but with sufficient cover, the soil historically has not been seriously affected.[48]Following Gutmann and Cunfer (1999, 9-10) wind erosion occurs as strong winds blow across dry soil. Beyond a threshold speed that varies according to soil characteristics and moisture, soil particles begin to move. The amount of erosion from a field is a function of the textural class of the soil (sandy soils are most vulnerable), slope, wind velocity, soil moisture, vegetative cover, surface aggregates (clumpiness lowers surface wind velocity), and size of exposed terrain. This latter factor introduces an externality, since if an adjacent farm is completely cultivated, wind erosion will gather momentum as it moves to the next farm. If, however, the adjacent farm has grass or stubble cover, wind erosion will be slowed. Accordingly, areas characterized by completely-cultivated homesteads contributed to more intense blowing, overwhelming farms that might have had more soil cover.

With homestead settlement of the Great Plains the conditions for increased wind erosion were established. The native grasses were plowed as the land was placed into crops, and intensive cultivation reduced the size of soil particles. The soil, especially in the southern plains, already was sandy, and the region was flat with little to obstruct wind. In the 1930s, severe drought and high temperatures also lowered soil moisture. The soil became dust and was picked up by the wind.

Drought in the 1930s was a triggering factor for the Dust Bowl, but it was not a sufficient condition. Figure 2 plots annual rainfall in three Great Plains states of Kansas, Montana, and

Colorado from 1895 to 1985. Notice that severe drought (precipitation one standard deviation below the mean) characterized the 1930s in all three states. Those were the Dust Bowl years. Notice too that the late 1950s and late 1970s were also periods of severe drought. Nevertheless, neither of the latter two periods had wind erosion comparable to that experienced in the 1930s.

We emphasize two major and related differences between the 1930s and the 1950s and 70s. One was that by the 1950s, there was greater knowledge of cultivation techniques and land use practices that could mitigate wind erosion. Second, there were fewer small, homestead farms. As indicated in Table 1 average farm size in the Great Plains in the 1930s was approximately 640 acres, whereas in the late 1950s, mean farm size was twice that at approximately 1,300 acres, and by the late 1970s, larger still at over 1,600 acres. The key-initiating factor for the 1930's Dust Bowl was cultivation, and small farms cultivated more of their land, and cultivated it more intensely than did large farms.[49]

Homestead farms also were too small to adopt the conservation practices that were found to be important for controlling wind erosion. USDA and Soil Conservation Service officials in the 1930s and subsequent investigators repeatedly cited small farms on the Great Plains as a principal source of the region's problems. They lamented the failure to adopt Powell's recommended 2,560-acre plots.[50] For example, Bennett and Fowler (1936, 6-7) stated that federal homestead policy to keep land allotments small and to require that a portion be plowed "is now seen to have caused immeasurable harm." The U.S.Great Plains Committee (1936, 3, 40-6, 75), appointed by President Roosevelt to address poverty and environmental damage concluded that "although we now know that in most parts of the Great Plains a farm of this size [homestead] is far too small to support a family. They were required to put this land under plow, regardless of whether or not it was suited to cultivation."

Small marginal homesteads had to be completely cultivated to earn sufficient income to support a family. They were continuously cropped and cultivated, raised few livestock and therefore had little pasture and the associated protective grass cover. With declining agricultural prices in 1933 and dry conditions, small farmers especially had to plant as much as possible on their plots to try to offset falling yields and returns. Cooper, et al, (1938, 146-8) claimed that farms "are so small that the establishment of a system of farming that will conserve soil and produce a desirable family income is practically impossible."

As the Dust Bowl continued through the 1930s, soil conservation recommendations included a variety of cultivation techniques—strip cropping, wide spacing of crops with double width rows and partial fallow, contour plowing, stubble mulching and specialized plowing that maintained stubble cover, and reduced tillage. All of these practices required leaving about half of a farm uncultivated each year and the use of specialized equipment (duck foot plows, bar blade and rod weeders, shearing blades, improved tractors and combines) as well as new drought-resistant grains.[51] With limited acreage and high fixed investments, small farms were less apt to use these techniques or have the appropriate equipment.

Diversification into livestock also was recommended because maintaining pasture retained grass cover, but given low grazing capacities livestock made sense only for large units (Starch, 1939, 119). Similarly, Thornthwaite (1936, 242) concluded that the small size of many farms precluded cattle raising and forced the cultivation of land which should have remained in grass, "…. in addition, the type of tillage which, because of its low cost, gives the farmer his only advantage is the primary cause of wind erosion so destructive in nature that it eventually renders the land unfit for cultivation."

IV. Transactions Costs and the Effect of Government Subsidies to Small Farms in the Slow Transition to Larger Farms.

The assignment of property rights to homesteads in the Great Plains created a small-farm path dependency that was slow to be corrected. Figure 3 presents mean farm size from1920 through 1987, constructed from census data for the Great Plains and the Midwest and for New South Wales, Australia.[52] New South Wales accounts for approximately one-third of Australian wheat production and has a climate similar to that found in the Great Plains. The Great Plains states include eastern Montana, eastern Colorado, the western Dakotas, western Kansas, and western Nebraska. The Midwestern states include Wisconsin, Minnesota, Iowa, eastern North and South Dakota, eastern Nebraska, and eastern Kansas.[53] The figure also shows the linear regression of farm size on time.

As illustrated, in the Midwest, farm sizes only gradually changed. Between 1920 and 1987 mean farm size approximately doubled from 175 acres to 371 acres, with the slope of the estimated adjustment equal to 3.3.[54] The experience of the Great Plains was quite different. Mean farm size in 1920 was 557 acres, and it tripled to 1,648 acres by 1987, with the slope of the estimated adjustment equal to 19.9. For New South Wales, farm size is 2,010 acres in 1920 and rises to 2,862 acres by 1978, the last year for which we have data. The slope of the adjustment is 5.9, which would be lower except for the spike in farm sizes in 1978. Even so, the adjustment path is more similar to that found in the Midwest than in the Great Plains.

The 160-acre limit of the Homestead Act was not a binding constraint in the Midwest. As late as 1920, a 160-acre farm was close to optimal in the region. From that time forward, only moderate farm-size adjustments took place in response to changes in the relative factor prices. Similarly, in New South Wales wheat farms started out large in 1920 and gradually

grew.[55] The homestead limit was binding on the Great Plains. Because of the dryer climate and variable precipitation that led to fluctuating yields, farms needed to be larger than the 160 or 320 acres allowed under the land laws. Through gradual consolidation of units, farm size increased over time, with the adjustment process slowing after 1959, suggesting by that time much of the "catch-up" from small homesteads had taken place. Indeed, the mean percent farm size change between census years from 1920 through 1959 in the Great Plains was 11.6 percent, but between 1964 and 1987 it dropped to 4.1 percent comparable to the mean percent change in the Midwest of 5.6 percent between 1920 and 1987.[56]

A comparison between changes in farm sizes in the Great Plains and Midwest over the 67-year period illustrates the property rights adjustment problems caused by starting with farms that were too small in the former region. If farm units on the Great Plains had not been constrained by the provisions of the land laws and if the factors influencing farm size adjustments had been the same in both regions, except for climate, it is possible to determine what the optimal farm size might have been in 1920. Figure 4 shows the trend in actual farm size between 1920 and 1987, a retrospective projection from 1987 farm size back to 1920, using the estimated Midwest farm size adjustment, and another hypothetical trend line if farm size had changed rapidly during the 1920s and 1930s in response to new information about the climate and adequate unit size. As shown in the figure, the retrospective movement results in a 1920 wheat farm size of 1,441 acres. Such a farm was 9 times larger than a 160-acre homestead and 4.5 times larger than a 320-acre homestead, as allowed by law, although still smaller than that found in New South Wales. The rapid adjustment path, unconstrained by government policy, would have led to more optimally-sized farms by the late 1930s, with subsequent changes following a pattern similar to that occurring in the Midwest. The gap between this line and the

actual trend represents the annual farm size adjustment that was delayed by government policy to maintain small farms.

Table 5 also describes the nature of the farm-size adjustment process on the Great Plains. It provides census data for two Great Plains states, Colorado and Montana for 1920 and 1982. In 1920, mean farm size in the two states was 408 and 608 acres, respectively. Most of the farms were less than 500 acres, and there was considerable heterogeneity in farm sizes as indicated by the coefficient of variation, which was 2.7 for Colorado and 2.3 for Montana. By 1982, however, mean farm size was much larger at 1,237 and 2,568 acres. Further, the variance in farm size had declined. The coefficient of variation was 1.67 for Colorado and .92 for Montana. Farm sizes had coalesced around the mean.

Following the drought of 1917-21, it became increasingly clear that homesteads were not viable farm units on the Great Plains, yet they persisted and were only gradually replaced by larger units, as reflected in Figures 3 and 4.[57] There are a number of reasons for the slow adjustment of farm sizes. One is that there was no abrupt end to homestead farms through severe drought. Precipitation varied by region and year, so that if homesteaders survived one drought, they stayed as conditions improved.[58] Farmers only had to cover the opportunity costs for variable inputs, labor and capital, and their human capital was linked to agriculture with few other options in the region other than migration. Hence, farmers were reluctant to sell, staying on their farms as long as possible. Another important reason is that small farmers were subsidized to continue.

Although in the early 1930s the Federal Government attempted to encourage out-migration and the formation of larger farms on the Great Plains through the Resettlement Administration, the policy had limited success.[59] In most cases the government purchase and

resettlement programs eventually were resisted.[60] Only 581,696 acres were purchased in the southern plains.[61] Opponents alleged that the government was buying farms during a period of distress and taking them out of production. Government lands were removed from the local tax base.

The real thrust of government policy through relief and Agricultural Adjustment Act payments was to sustain family farms. Neither local politicians nor officials of the Department of Agriculture wanted to see a dramatic loss of farmers in the region. In its 1938 Yearbook of Agriculture, "Soils and Men," the agency noted the debate over whether to move farmers out of farming or to subsidize them, and sided with the latter: "it is wise to keep a large rural population"(pages 3-4). The department stood to lose much of its constituency in the region. Clawson, Saunderson, and Johnson (1940, 42-8) claimed that eliminating farms of less than 300 acres in eastern Montana would reduce the number of farms by 76 percent. But they doubted that many would be willing to accept such drastic steps. They still called for the elimination of 50 percent of the farms in the region from 1928-35 levels, and predicted it would take 30 years to do so with considerable government assistance.

Thornthwaite (1936, 243-5) suggested that the Great Plains could sustain only two-thirds of the 1930 population.[62] But Great Plains politicians feared such a loss in farm population and the related deterioration in local economic activity and national political influence. The number of representatives in the House was at stake, as were property values in rural communities and related investment in schools and other infrastructure. They lobbied for subsidies to maintain small farms through the Farm Security Administration, the Works Progress Administration, the Farm Credit Administration, and the Federal Emergency Recovery Administration. For example, $525 million was authorized in June 1934 for the region as drought relief.[63] The major

historian of the Dust Bowl, Donald Worster (1979, 131-5) estimated that 3 out 4 farmers in the region received federal aid. Johnson (1947,190) noted that in some areas as many as 80 percent of the farmers were on relief. A March 1935 survey indicated that up to 40 percent of farm families in the Texas panhandle, over 50 percent in southeastern Colorado, and between 33 and 50 percent in southwest Kansas was dependent on government payments. Between September 1933 and August 1935, FERA granted $32,666,370 to Colorado, Kansas, and Oklahoma for relief. Those not on relief were able to stay on their farms mainly because of crop adjustment payments from the AAA. Between 1933 and 1936, total federal aid averaged $223/person in 72 southern plains counties.[64] The subsidies, however, helped to sustain many otherwise non-viable small farms, delaying the adjustment toward larger farm sizes.[65] Wheat farms received approximately one third of their income from federal subsidies (Rucker and Alston, 1987).

Small farmers became an important political constituency. Although, larger units gradually replaced homesteads, the "family-farm" lobby became increasingly effective in securing preferential government support. In the 1930s and later in the 1970s, the lobby was able to secure legislation in Great Plains states to prohibit large 'corporate' farms.[66]

VI. Conclusion.

The Homestead Acts resulted in the formation of farms that were inappropriately small for the semi-arid Great Plains. Cultivation practices on those farms had important environmental consequences during drought. Had there been more complete knowledge of the climate and agricultural techniques suitable for the region in the late nineteenth and early twentieth centuries, the land laws might have been more significantly broadened to allow for much larger property rights allocations. As it was, the area was settled densely with small, family farms along a midwestern model. The process of consolidation of 160 and 320-acre homesteads into more

viable units took a very long time. In the mean time, homesteads were more vulnerable to failure during drought, and we argue they disproportionately contributed to the Dust bowl of the 1930s.

A lack of alternatives and government relief and agricultural subsidies beginning in the 1930s slowed the reallocation of property rights by providing income supplements to small farmers. Regional politicians sought to maintain family farms and to prevent a sharp decline in rural population. Gradually, larger farms replaced homesteads, but family farms remained a powerful political constituency. This case illustrates the difficult environmental problems that can be raised by an inappropriate assignment of property rights. It cannot be assumed that a more efficient allocation of rights with fewer negative environmental effects will occur quickly. In this situation, government policies raised the transactions costs of the reallocation of property rights to more efficient units.

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Table 1
Average Farm Size in the Midwest and Great Plains
1880-1982

Midwestern States							
Year	**Mean Farm Size**	**Percent of Farms< 500 acres**	**Number of Farms**	**Year**	**Mean Farm Size**	**Percent of Farms< 500 acres**	**Number of Farms**
1880	174	99	845,520	1950	203	95	1,002,568
1890	152	98	971,215	1954	218	94	924,557
1900	164	97	1,119,083	1959	243	92	815,340
1910	174	97	1,088,176	1964	273	89	721,853
1920	175	97	1,113,454	1969	299	87	640,726
1925	170	97	1,119,424	1974	324	85	579,707
1930	179	97	1,099,309	1978	339	82	553,780
1935	172	97	1,173,768	1982	347	81	526,421
1940	183	96	1,097,485	1987	371	77	481,760
1945	195	95	1,049,568				
Great Plains States							
Year	**Mean Farm Size**	**Percent of Farms< 500 acres**	**Number of Farms**	**Year**	**Mean Farm Size**	**Percent of Farms< 500 acres**	**Number of Farms**
1880	186	99	44,278	1950	1,055	53	160,824
1890	226	96	102,353	1954	1,145	50	151,654
1900	431	84	107,483	1959	1,303	45	134,073
1910	398	82	201,227	1964	1,477	42	120,859
1920	557	71	223,782	1969	1,500	42	116,844
1925	541	70	217,589	1974	1,596	41	109,299
1930	636	64	220,002	1978	1,630	40	105,814
1935	642	65	227,810	1982	1,665	41	101,262
1940	779	60	191,097	1987	1,648	43	103,705
1945	972	53	170,901				

Source: U.S. Agricultural Census. Great Plains states include eastern Montana and Colorado counties, western counties of the Dakotas, Nebraska and Kansas. Midwestern states include eastern counties of the Dakotas, Nebraska, Kansas, as well as the states of Wisconsin, Minnesota, Iowa, and Illinois.

Table 2
Congressional Voting on the Enlarged Homestead Act

Independent Variables:	**Dependent Variable:** Yes Votes (of Total State Yes, No, and Abstentions)	**Dependent Variable:** Abstentions (of Total State Yes, No, Abstentions)
Constant	-0.66* (0.16)	-0.28E-01 (0.15)
%Change in Population, 1900-1910	1.64* (0.46)	-0.64** (0.42)
Value of Corn Production, 1910	0.30E-08* (.14E-08)	-0.36E-08* (0.14E-08)
Value of Manufacturing, 1910	-0.32E-06* (0.99E-07)	0.24E-06* (0.93E-07)
Republican Party	0.86E-01 (0.14)	0.53E-01 (0.14)
N	382	382

Standard Errors in parenthesis
* Significant at 95% or better
**Significant at 85%

Table 3
Drought Survival and Farm Size
Cascade and Fergus Counties, Montana

Fergus County	**Number of Farms**	**Average 1916 Farm Size (acres)**
Total	3,960	315
Survivors through 1922	1,272 (32%)	372
Non-survivors	2,688 (68%)	288
Survivors through 1930	559 (14%)	372
Cascade County		
Total	2,193	328
Survivors through 1923	734 (33%)	373
Non-survivors	1,459 (67%)	306
Survivors through 1929	313 (14%)	424

Table 4

Dependent Variable: Survival (0,1)	
Explanatory Variables	**Coefficient**
Community Dummies: Joliet*	-1.204 -(2.89)**
Roberts	-0.964 -(2.06)**
Edgar	-0.107 -(0.20)
Silisia	-0.577 -(1.23)
Age	0.0208 (2.53)**
Total Crop Acres	0.00306 (1.78)***
Pasture Acres	-0.00223 -(1.81)***
Value of Livestock	0.00028 (1.74)***
Value of Wheat Sales	0.00042 (1.57)
Farm Value per Acre	-0.00949 -(2.02)**

*Boyd is the baseline Community
**Significant at 5% level
***Significant at 10 % level

Table 5
Farm Size Adjustment on the Great Plains, 1920-1982
Montana and Colorado

1920		
Number of Farms	**Montana**	**Colorado**
Less than 100 acres	4,350	15,294
100-499 acres	35,723	33,750
500-999 acres	11,982	7,482
Over 1,000 acres	5,622	3,408
Total	57,677	59,934
Mean Farm Size	608 acres	408 acres
St. Deviation	1,402	1,119
C.V.	2.30	2.74
1982		
Number of Farms		
Less than 100 acres	5,593	9,252
100-499 acres	4,808	7,761
500-999 acres	2,640	3,337
Over 1,000 acres	10,529	6,761
Total	23,570	27,111
Mean Farm Size	2,568 acres	1,237 acres
St. Deviation	2,359	2,071
C.V.	.92	1.67

Source: U.S. Census

Figure 1
The Great Plains

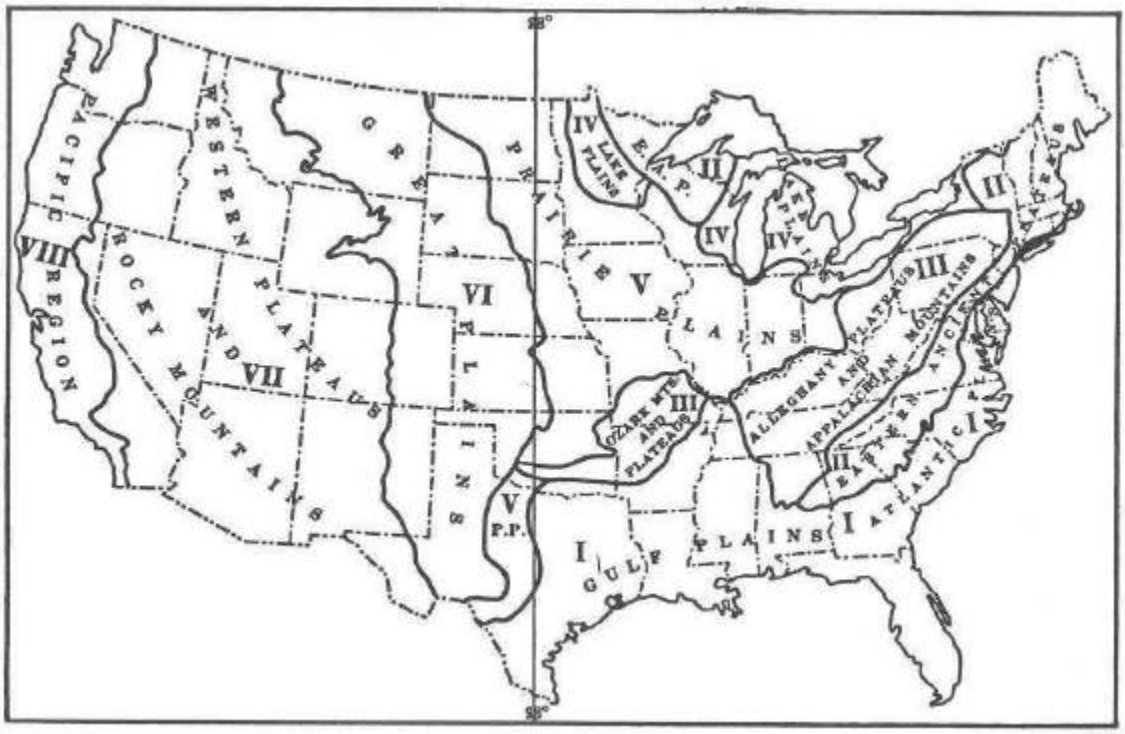
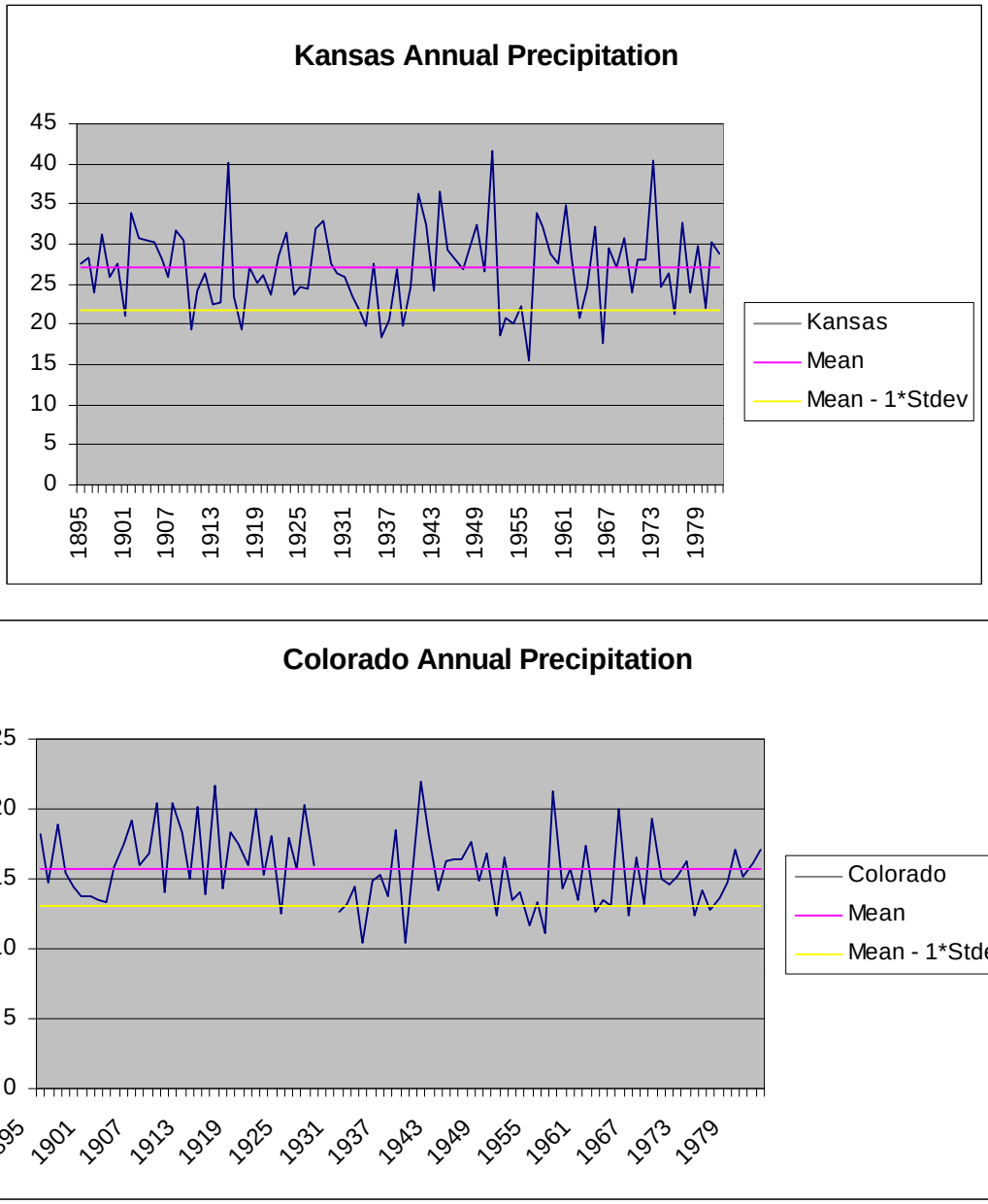


Figure 2
Annual Precipitation in the Great Plains States of Kansas, Colorado, and Montana
1895-1985



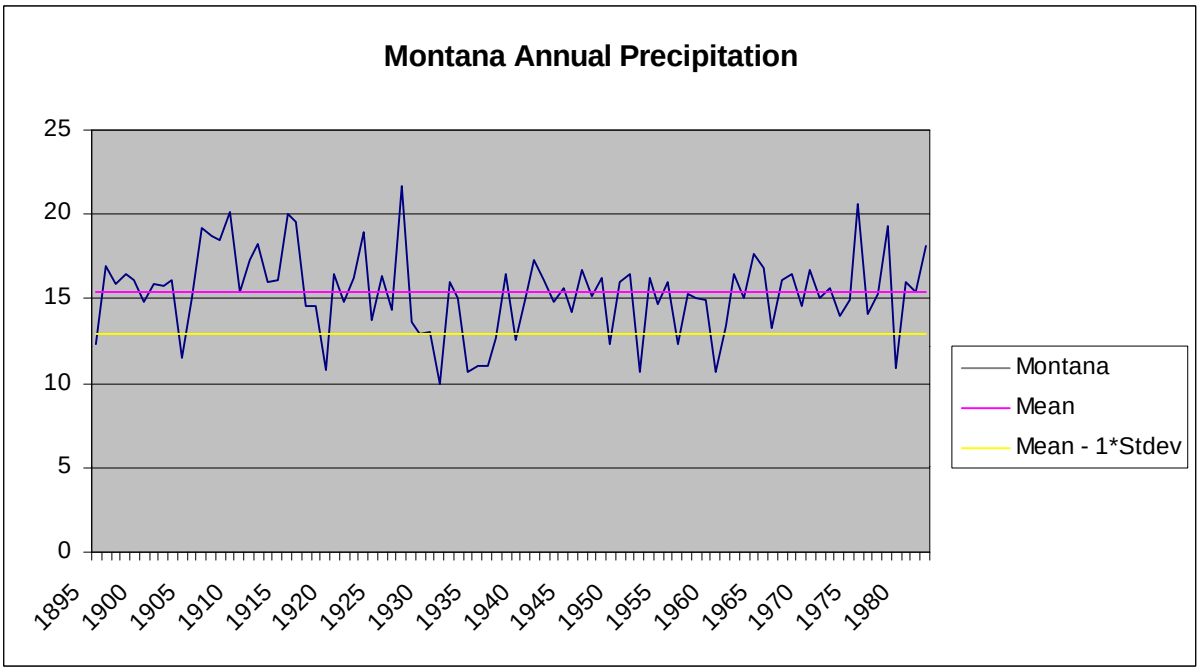

Montana Annual Precipitation
25
20
15
10
5
0
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
Montana
Mean
Mean - 1*Stdev

Figure 3

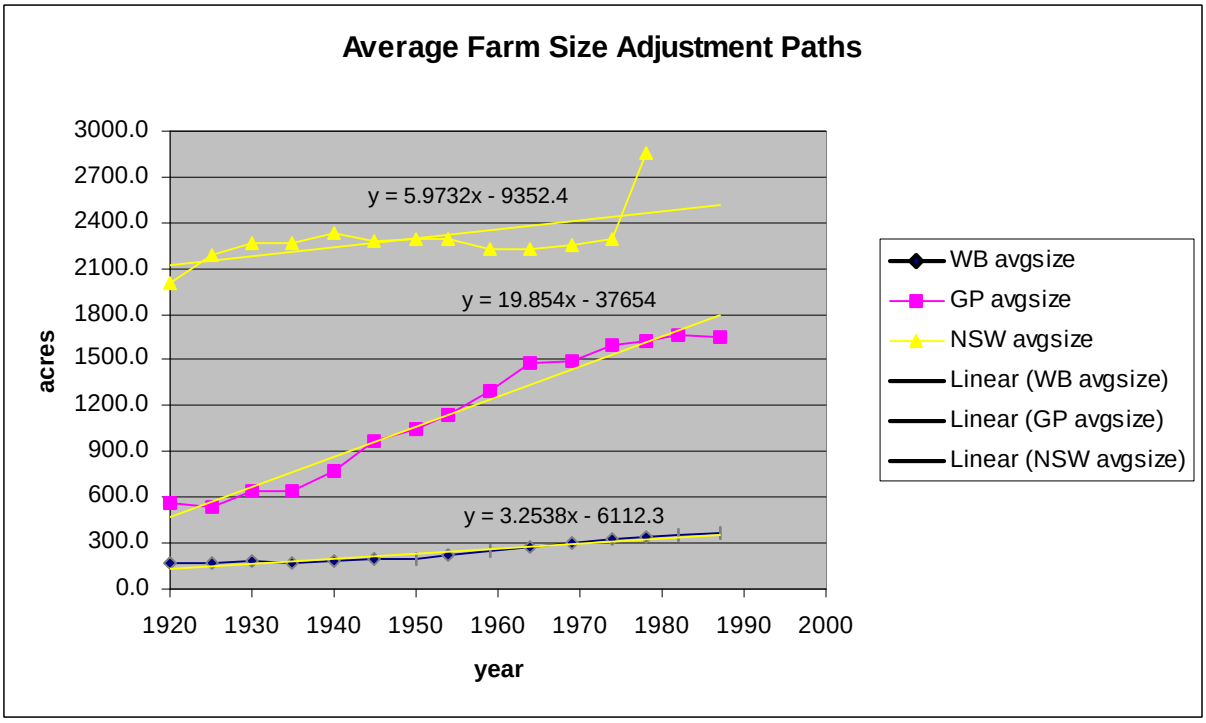
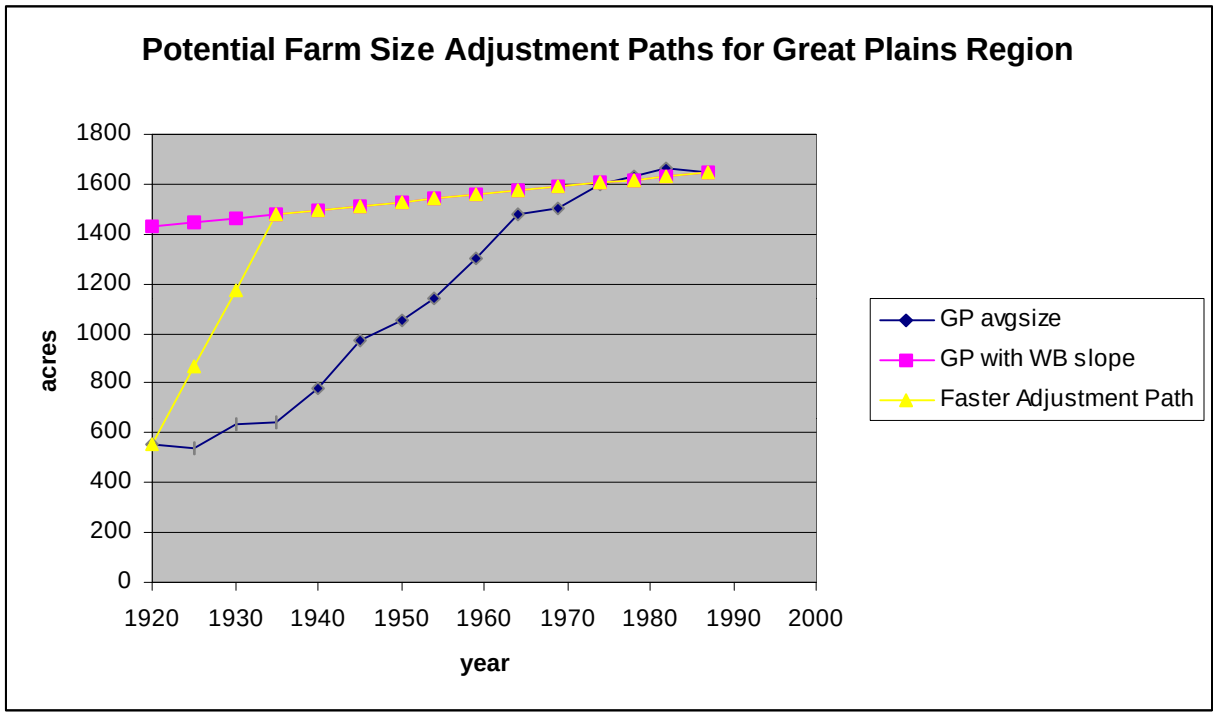

Average Farm Size Adjustment Paths
3000.0
2700.0
2400.0
2100.0
1800.0
1500.0
1200.0
900.0
600.0
300.0
0.0
acres
y = 5.9732x - 9352.4
y = 19.854x - 37654
y = 3.2538x - 6112.3
1920
1930
1940
1950
1960
1970
1980
1990
2000
year
WB avgsize
GP avgsize
NSW avgsize
Linear (WB avgsize)
Linear (GP avgsize)
Linear (NSW avgsize)

Figure 4


Potential Farm Size Adjustment Paths for Great Plains Region
acres
1800
1600
1400
1200
1000
800
600
400
200
0
1920
1930
1940
1950
1960
1970
1980
1990
2000
year
GP avgsize
GP with WB slope
Faster Adjustment Path

Endnotes

[1] We are analyzing the relationships between small farms and their cultivation practices and wind erosion. We also are examining the effects of federal government subsidies on the persistence of small farms on the Great Plains. We are collecting data and this draft represents our preliminary results and arguments. In the 1950s and 1970s there were dust storms in the Great Plains, but not of the magnitude of the 1930s.

[2] Coase (1960, 16). See also Demsetz (1967, 349) for elaboration.

[3] Allen (1991) offers a different explanation for federal land policy, especially the Homestead Act. He argues that homesteading was a means of promoting dense settlement on the frontier and hence, reducing government enforcement costs.

[4] Coxhead (2001) examines a similar case where government policy has inadvertent negative environmental consequences. He argues that corn price support programs in the Philippines encourage expansion of cultivation in frontier, upland agronomic zones and correspondingly to land degradation through greater erosion. He concludes that environmental consequences should be considered in evaluating agricultural policies aimed at self sufficiency and price stability. Alban Thomas brought this study to our attention.

[5] Even though there are fewer small farms today and current farms are larger than in the past, they remain an important political constituency. See Knoeber (1997). Allen and Lueck (1998) offer a model to explain the dominance of the family farm organization, especially in areas where there were few gains from specialization, potential moral hazard problems, and important timing or seasonal risks, such as characterize the Great Plains.

[6] Quoted in Hibbard, (1924, reissued 1965, 143). An example of the congressional debate over the need to reserve federal land for small farmers ("free homes for homeless people") is in Congressional Globe, 37 Congress, 2nd Session, Wednesday May 7, 1862 (page1915).

[7] Alban Thomas of Toulouse University suggested a more formal version of this framework.

[8] Julian (**, 336).

[9] Powell's report, "Report on the Lands of the Arid Region," 45th Congress, 2nd Session, House Executive Document 73, was transmitted to the Commissioner of the General Land Office on April 1, 1878. Another edition of 5,000 copies was made in 1879 by Congress. One bill allowed for 9 or more individuals to organize into irrigation districts and take up land when certified as irrigable and the other authorized pasturage homesteads of at least 2,560 acres granted as part of grazing districts made up of 9 or more individuals pooling their animals in common herds. Later, USDA and Extension Service personnel concluded that the failure to adopt Powell's recommendation was a critical policy error. See for example, the Report of the U.S.Great Plains Committee (1936, 1,3, 7, 40, 42). Kimmel (1940, 266) among others stated that farm reorganization was necessary in order to put into place "agriculture that should have been established in the first place. Had Major Powell's recommendation become a part of the national land policy in the 1870's many of the problems that now exist never would have occurred."

[10] Worster (2001, 358-63) claims that inaction came from a lack of desire of congressmen to consider the scientific evidence on the region. But as Libecap and Hansen (2001) describe, there was no clear body of science about the weather or agriculture of the region.

[11] Congressional Record, 45th Congress, 3rd Session, 1202-3.

[12] Congressional Record, 45th Congress, 3rd Session, 221, quoted in Worster (2001, 367). See Maginnis' warning of monopoly and large estates like those of the Spanish land grants, Congressional Record, 45th Congress, 3rd Session, 1201.

[13] For discussion of the reaction to Powell's report, see Stegner (1953, 219-42). See Peffer (1951, 8-62, 135-68) regarding the political controversy over homestead farm size, the claims of ranchers, and efforts to adjust the federal land laws.

[14] The only support came from representatives of eastern states. See Smith (1950, reissued 1970, 199).

[15] The commission members were Clarence King of the new Geological Survey, John Wesley Powell, James Williamson, Commissioner of the General Land Office, Thomas Donaldson and Alexander Britton. Report of the Public Lands Commission, 46th Congress, 2nd Session, House Executive Document 46, February 25, 1880, xxiii. The commission took testimony primarily in Nevada, Utah, California, and the Pacific Northwest.

[16] Libecap and Hansen (2001) examine the weather information problem facing migrants to the Great Plains. Renne (1936a, 33) also describes the weather information problem confronting settlers. Thornthwaite (1936, 202-7), discusses the early lack of information about the region's climate and type of farming that could adapt to it. See also, Kraenzel (1955, 12-23).

[17] Annual Reports of the Commissioner of the General Land Office for the Fiscal Years, 1880-1925. The calculations are for state totals.

[18] The residency requirement for the 1909 law was reduced to three years in 1912 and cultivation was reduced to 160 acres. Other land law changes were the 1873 Timber Culture Act that granted an additional 160 acres if cultivation of trees occurred on 1/4 of the lot; the 1877 Desert Land Act which granted up to 640 acres if part of the farm were irrigated (but in a dry region, this had limited potential); the 1878 Timber and Stone Act which granted 40-160 acres for accessing timber or stone for agricultural purposes, and the 1916 Stock Raising Homestead, which granted 640 acres for raising cattle in selected states.

[19] 35 Stat. 693. The law was passed February 19, 1909 in the 60th Congress, 2nd Session. This was one of the few land laws where there are recorded votes for analysis. Data are from the 13th Census of the United States, 1910.

[20] See for example statements given by Senator Gallinger of New Hampshire, Congressional Record, 60th Congress, Second Session, 4214. The objectives to promote actual settlement of small farmers and avoid large accumulations of privately held land are repeated throughout the public lands literature. See Peffer (1951, 134-169) and Hibbard (1924, 386-410).

[21] Congressional Record, 60th Congress, Second Session, 6098, House of Representatives. There were 387 voting, answering "present" or abstaining: 141 yeas, 74 nays, 160 abstentions, and 12 "present." We considered the 12 who answered "present" as abstaining, giving 172 abstentions. We dropped the 5 Oklahoma observations in the analysis because of a lack of data for the independent variables. We estimated the equations using both Probit and OLS, and report the Probit results. They are virtually the same.

[22] Peffer (1951, 33-58). For example, Senator Preston Plumb of Kansas had opposed opening up new land in 1888 through irrigation, claiming that there was still plenty of land and opportunity in Kansas, Nebraska, and Minnesota, Congressional Record, **Congress, ** Session, July 30, 1888, 7021-22.

[23] The South had historically opposed homesteading and the Republican party had historically favored it.

[24] Correlation coefficients among some of the independent variables are . -.40 for corn state and population change and -.41 for value of manufacturing by state.

[25] Early establishments were ranches and often large. Most of the land was held without formal title. Homestead entry intruded on ranches. See Libecap (1981). The data are from County Directories. County Directories were

assembled and published privately by R.L. Polk and W.T.Ridgley and are available for many U.S. counties at the Library of Congress. They are not annuals and the data often vary.

[26] For example, the classic discussion of the Great Plains is by Webb (1931, 408) and he argues that homesteads were too small: "160 acres of land in the humid region was equivalent in productiveness to 2560 acres in the arid region. Other studies that concluded that 160-acre homesteads were too small includes Stephens (1937) and Starch, (1936, 14-19).

[27] Huffman and Paschal (1942) argue "A misguided land settlement policy of the federal government resulted in the settlement of a large part of the Northern Great Plains in relatively small tracts."

[28] Calculated from U.S. Department of Commerce, Historical Statistics, 1975, 510, 519 for nominal wheat and livestock prices and 210-11 for the CPI index used as the deflator.

[29] See Kraenzel, (1942, 583-6), "On the whole, farms are too small in the Great Plains region. This is the result of homesteading practices." He called for diversification. Stephens (1937, 751), and Bennett and Fowler (1936, 4).

[30] Eckert and Maughan (1939, 23-4), Kimmel (1940, 265-6). See Alston (1983) for analysis of farm foreclosures during the interwar period. Great Plains states were particularly hard hit.

[31] The survivors and non-survivors are identified by matching the full name of individuals in the directory, including the middle name or middle initial. For Fergus County, the following probit equation was estimated:

Survival 1916 to 1922 (yes/no) = constant + b_1 farm size in 1916

Survival 1916 to 1930 (yes/no) = constant + b_1 farm size in 1916 (these farms survived into 1922, then into 1930), and for Cascade County:

Survival 1916 to 1923 (yes/no) = constant + b_1 farm size in 1916

Survival 1916 to 1929 (yes/no) = constant + b_1 farm size in 1916 (these farms survived into 1923, then into 1929)

Dependent Variable: Survival (0 / 1)	**Coefficient (Std. Error)**	**Marginal Effects (Std. Error)**
Fergus Probit Results (1916 to 1922)		
Constant	-0.57 (0.028)	- 0.206 (0.86 E-2)
Size of Farm in 1916	0.344 E-3 (0.58 E-4)	0.123 E-3 (0.21 E-4)
Fergus Probit Results (1916 to 1930)		
Constant	-1.14 (0.031)	-0.254 (0.407 E-2)
Size of Farm in 1916	0.19 E-3 (0.56 E-4)	0.43 E-4 (0.12 E-4)
Cascade Probit Results (1916 to 1923)		
Constant	-0.50 (0.354)	-0.183 (0.011)
Size of Farm in 1916	0.225 E-3 (0.66 E-4)	0.82 E-4 (0.24 E-4)
Cascade Probit Results (1916 to 1929)		
Constant	-1.07 (0.04)	-0.26 (0.54 E-2)
Size of Farm in 1916	0.29 E-3 (0.66 E-4)	0.72 E-4 (0.16 E-4)

For Fergus, results indicate that for 1,000-acre increase from the average farm size, the probability of survival from 1916 to 1922 increases by 0.12. This small increase in probability is likely to be due to the problem of not being able to control other factors, such as experience or land quality. Similarly, for 1,000 acre-increase from the mean, the probability of survival from 1916 to 1930 increases by 0.04. The probability of survival from 1916 to 1922 at the 1916 mean farm size of 315.1 is 0.32. The probability of survival at mean plus one standard deviation of farm size (i.e. 708 acres) is 0.37. For a farm of 1,000 acres, the probability of survival is estimated to be 0.41, and for 1,425 acre farm the probability of survival increases to 0.47. Survival probabilities to 1930 are much lower: from 1916 to

1930 at the overall mean of 315.1 acres it is only 0.14 and at the mean plus 1 std. deviation (708 acres) it 0.16. The survival probability to 1930 rises only to 0.17 when farm size is 1,000 acres.
For Cascade, the results indicate that for 1,000-acre increase from the average farm size, the probability of survival from 1916 to 1923 increases by 0.08. Similarly, for 1,000 acre-increase from the mean, the probability of survival from 1916 to 1929 increases by 0.03. The probability of survival from 1916 to 1923 at the overall 1916 mean farm size of 328.3 acres is estimated to be 0.33. There is a 33% chance that a farm with average acreage would survive into 1923 from 1916, given the 1916 farm size. Survival probability rises to 0.37 at 750.1 acres (mean + one std. deviation). Survival probability to 1929 is much lower at the mean acreage of 328.3; the probability of survival into 1929 with mean acreage is 0.17, and with mean + one std. deviation is only 0.2. The survival probability to 1929 rises to 0.22 when farm size is 1,000 acres.

[32] Data used in this analysis are compiled from two sources: Carbon County Directories, 1916, 1919, 1922, R.L. Polk and W.T.Ridgley, from the Library of Congress and the 1919 Agricultural Census Manuscript for Carbon County, Montana, US National Archives. Prices received by farmers for wheat, oats and potatoes sold are compiled from the USDA.

[33] We include farmers that were listed in 1922 but not in 1919 for some reason, but had to have been there in 1919.

[34] A "non survivor" might have failed due to drought, might have sold the farm, or passed it along to heirs. We cannot distinguish among these options, but attempt to control for them in the statistical analysis.

[35] The county directories include the farmer's name, acreage, assessed value, and post office location. Because some names are common ones, to distinguish farmers we relied on post office addresses.

[36] Farmers older than 65 in 1919 might not have "survived" because of health or death, rather than due to the effects of drought. We also use dummy variables to control for fixed effects of location. Location is based on post office addresses given in the county directories. These included Red Lodge, Luther, Laurel, Boyd, Joliet, Edgar, Silisia, and Roberts. Because some communities had all non-survivors, they too were dropped from the analysis, affecting 14 farmers.

[37] Age was consistently significant at 5 percent or better in various runs. Other experience variables considered were years as farm owner, years as farm operator, and whether the individual owned the farm (yes/no), but none performed as well. We also considered including sex, but almost all farmers were male.

[38] This variable is pasture for livestock only, deleting pasture for crops as included in the census. The total crop acres variable already includes crop land.

[39] We considered a variety of financial and capital variables constructed from the census and most did not perform well, possibly because they were either not complete or well defined.

[40] The value of livestock is for livestock that can be sold. We do not include horse value since horses were capital stock for these farms and used in plowing the cultivated acres.

[41] We experimented with a variety of wheat and crop variables in levels and shares. The value of winter and spring wheat sales was by far the most powerful variable.

[42] The descriptive statistics are:

Variable		**Mean**	**Std. Dev.**
Joliet*		0.44	0.50
Roberts*		0.17	0.38
Edgar*		0.10	0.30
Silisia*		0.15	0.36

Age		44.98	11.02
Total Crop Acres		144.58	96.56
Pasture Acres		146.39	136.31
Value of Livestock		1426.49	4231.39
Value of Wheat Sales		238.27	612.95
Farm Value per Acre		49.28	42.32
*Town dummies. Left-out town is Boyd.			

[43] The historical literature on the Dust Bowl is large, but not very analytical. Gutmann and Confer (1999) is an exception. Standard references include Worster (1979), Hurt (1981), and Bonnifield (1979). The USDA and agricultural economics literature provide more quantitative data. For an assessment of its impact, see Worster (1979, 5, 12, 13, 29, 22-24) and Bennett (1939, 55-87). Bennett was head of the Soil Conservation Service.

[44] Bennett (1939, 119-21).

[45] Thornthwaite (1936, 238-40). In 1936 Bennett and Fowler (1936, 8) claimed that because of the dust storms of 1934 and 35, 80 percent of the Great Plains were in some state of erosion, with "as much as 15 percent may already have been seriously and permanently injured."

[46] 1938 Yearbook of Agriculture, "Soils and Men," page 71.

[47] Bennett (1939, 118).

[48] Stephens (1937), Starch (1939), U.S. Great Plains Committee, (1936, 27-32) reported that the climate of the region was uncertain with light rainfall and the windiest conditions in the US. Clements (1938, 199) argued that cultivation was the key causal factor in the Dust Bowl. Gutmann and Cunfer (1999) point out that drought conditions associated with the Dust Bowl have long characterized the Great Plains. Whether or not wind erosion as severe as that of the 1930s occurred earlier is unknown. If our hypothesis is correct, it is unlikely. In their study, Gutmann and Cunfer statistically examine the determinants of dust storms between 1961 and 1988 for 39 weather stations in the Great Plains where relatively complete data exist. Because data are not available for the Dust Bowl years, they use the estimated coefficients to predict the incidence of dust storms for Great Plains counties between 1930 and 1990. Their results under predict the number of dust storms for 1934-35, the test period. They argue that unusually high temperatures during that time were major contributing factors.

[49] The 1937 Yearbook of Agriculture, pages 33-37 commented on the severe drought that prevailed in 1936 and for the previous 3 years. Gutmann and Cunfer (1999) argue that high temperatures in the 1930s played a critical role. They agree that cultivation practices compounded conditions. They do not find a clear relationship between wheat acreage and the incidence of wind erosion. But they do not examine cultivation practices on small farms.

[50] Worster (1979, 85). In examining the causes of the Dust Bowl, Bennett, Kenney, and Chapline (1938, 68-76) criticized past homestead policies and pointed to "repeated attempts at too intensive use of the soil have resulted in serious problems of depletion, in destruction of physical resources…."Kimmel (1940, 264) linked the Dust Bowl to the dense settlement of the plains by homesteaders who put the land into cultivation, displacing grass land. Bennett and Fowler (1936, 4-10) emphasized the use of farming practices that were brought from the East, but inappropriate for a semi-arid region. They particularly pointed to excessive plowing. They also pointed to overgrazing as contributing to the removal of land cover. How important this was in a region dominantly in grain is unclear. Ranchers did have very uncertain property rights to range land because they could not obtain title to the land that they used under the land laws. For discussion of this issue, see Libecap (1981).

[51] 1938 Yearbook of Agriculture, "Soils and Men," pages 686-688. Summer fallow was the greatest source of moisture conservation. Hewes (1979, 167) discusses the costs of summer fallow, but does not make specific

reference to whether small farms used it or not. Kraenzel (1955, 311) also discusses the problems of small farmers with a maximum of 320 acres. He noted that summer fallow could not make progress until farms were large enough. See also, Clawson, Saunderson and Johnson (1940, 36-41). Renne, (1936a, 33) argued that ranches in the Great Plains had to be 6 to 8,000 acres to sustain a minimum sized herd of 200 animals and a farm 800 acres to allow for a minimum of 400 acres in crop and 400 acres in fallow each year.

[52] Farm size data for New South Wales are from Vamplew (1987, 72-3). Both the U.S. and Australian data sets include crop and pasture land.

[53] For the transitional states that were bisected by the 100th meridian we used county data following the Great Plains division described in Hargreaves (1957) for Montana and the Dakotas and Fite (1966) for Kansas. We connected these divisions through Nebraska. We also used just the eastern, non-mountain counties of Colorado.

[54] Kislev and Peterson (1982) analyzed the growth in farm size for the United States as a whole from 1930-1970, where per farm size grew at an annual rate of 2.2 percent. They attribute this growth to changes in the relative price of farm labor to machinery, which grew at almost the same rate. Further, they argued that technical improvements were similar across machine types.

[55] For discussion of Australian land policy, see **

[56] These are the mean percent changes in farm size calculated from census period to census period using the data from Table 1.

[57] Through the 1920s and 30s, USDA and extension service officials were extremely critical of past land policy and the small homesteads it created. During the 1930s, there were repeated calls for Federal Government policies to promote farm consolidation and the resettlement of "stranded farm families For example, see Johnson (1937, 153) and U.S. Great Plains Committee (1936, 79).

[58] U.S. Great Plains Committee (1936, 1) argued that many of the region's problems were associated with past land laws that encouraged homestead settlement. The committee noted that even so, the farmers "were in no mood to abandon their land." Noll and Krier (1990) summarize some implications of cognitive psychology for decision making that may describe the actions of homesteaders to stay on the farm during a drought. The use of representativeness heuristic whereby people use an analogy to previous, less drastic circumstances to evaluate their chances of surviving a drought may apply. They also describe a reflection effect whereby individuals are risk averse as to gains but risk taking as to losses.

[59] Renne (1936b, 49), Hargreaves (1976, 565-68). The various agencies involved in farm support and population resettlement included Federal Emergency Relief Organization (1933-35), Resettlement Administration (1935-7), Farm Security Administration (1937-8), and Soil Conservation Service (1938).

[60] Worster (1979, 42-6). The Farm Security Administration took over for the unpopular Resettlement Administration. But the Farm Security Administration, with its emphasis on small farmers, also faced political reaction from organizations representing larger farmers, such as the Farm Bureau Federation.

[61] Hurt (1985, 249-58).

[62] He called for the slow removal of 900,000 people or 210,000 families. He presented numbers of "surplus families" by state: North Dakota 7,360, Montana 12,610, Colorado 2,580, Texas 12,200, Oklahoma 2,930, Kansas, 6,100, Nebraska 4,930, and South Dakota 4,640. Worster (1979, 48, 59-60). Great Plains Committee (1936, 72) stated that 165,000 individuals had moved from the Great Plains by 1936.

[63] Worster (1979, 37-40, 124). The Secretary of Agriculture, Annual Report, (1943, 176) noted that Farm Security Administration Loan recipients are usually small farmers.

[64] Bennett (1939, 90) noted that farms in the Great Plains required more government loans, credit, and other forms of relief. Thornthwaite (1936, 246) stated that "It is evident that many of the farmers have been able to remain on their land only through a succession of loans." Johnson (1937, 162) stated that failing farms have appealed to Congress for seed and feed loans and other relief. In some counties the total of feed and seed loans and relief aid poured into some counties since 1929 exceeded the purchase value of the dryfarming land. The U.S.Great Plains Committee (1936, 5, 55-8) estimated that between April 1933 and June 1936 the Federal Government provided aid that in some counties equaled $200 per person and noted the excessive dependency of farms in the region on various forms of federal relief.

[65] Saunderson, Haight, Peterson, and Willard (1937, 18) were critical of the effects of government relief which delayed adjustment toward more viable farm units.

[66] This action maintained the strength of their political coalition (Knoeber, 1997). Allen and Lueck (1998) argue that corporate farms were unlikely to form in regions like the Great Plains where there were few economic gains from specialization.