AN ECOLOGICAL STUDY OF OKLAHOMA FARMS AND FARM POPULATION

BY

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CHAPTER I

Introduction

Statement of the Problem

Employing the theories of agricultural location, metropolitan dominance, and a hierarchy of central places and market areas as conceptual tools, this study correlates rural-farm population characteristics and agricultural land utilization with proximity to urban centers. Since urban influence wanes as distance from cities increases, these concepts signify a concomitant increase in remoteness and extensive land uses, larger farm units, and a corresponding decline in the density of the farm population. Conversely, as one moves from the rural hinterland toward larger market centers, land uses progressively intensify, farm units decrease in size, and farm population density rises.

According to the analytical models, the size of the urban center, the distance from it, and the variation in soil quality and physical resources are significant factors in producing differentials in both population composition and in agricultural land uses. Therefore, the objective of this ecological analysis is to ascertain the urban influence on the rural countryside, establishing which characteristics vary uniformly with accessibility to major cities.

Scope of Study and Sources of Data

Because of the small number of counties in the State, the analysis utilizes minor civil divisions (townships) as the basic units of observation. Moreover, the study uses the most recently published crop and livestock data, those for the years 1944 and 1945. Published agricultural censuses for the 967 Oklahoma townships are unavailable for later years.

The study employs population statistics from the Census of Population 1940 and 1950; crop, livestock, and farm population data from the 1945 Census of Agriculture; and highway mileage figures from the 1945 Rand McNally Road Atlas. Also, it uses the type of farming area classifications and productive man work units developed by the Department of Agricultural Economics, Oklahoma State University.

Method of Study

First, the study classifies each of the 967 Oklahoma townships into its predominant type of farming area, according to the map shown in Figure 1.

Second, it selects twelve major urban centers as follows: All cities having populations of 25,000 or over, located in Oklahoma or in the nearby areas of contiguous states, were included.[1] Also, if a city of 20,000 to 25,000 population was fifty miles or more from any of the other selected places, it was included.[2]

Third, the study classifies the townships into areas of urban

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[1]The twelve urban centers selected along with the January 1, 1945, estimated population of each is as follows: Oklahoma City, 219,961; Tulsa, 162,155; Denver, Colorado, 356,878; Dallas, Texas, 339,828; Wichita, Kansas, 132,280; Amarillo, Texas, 59,149; Wichita Falls, Texas, 52,334; Ft. Smith, Arkansas, 40,703; Joplin, Missouri, 37,850; Muskogee, 34,375; Enid, 31,015; and Lawton, 22,181.

[2]Lawton, with an estimated population of 22,181, was the only city with fewer than 25,000 inhabitants in 1945.

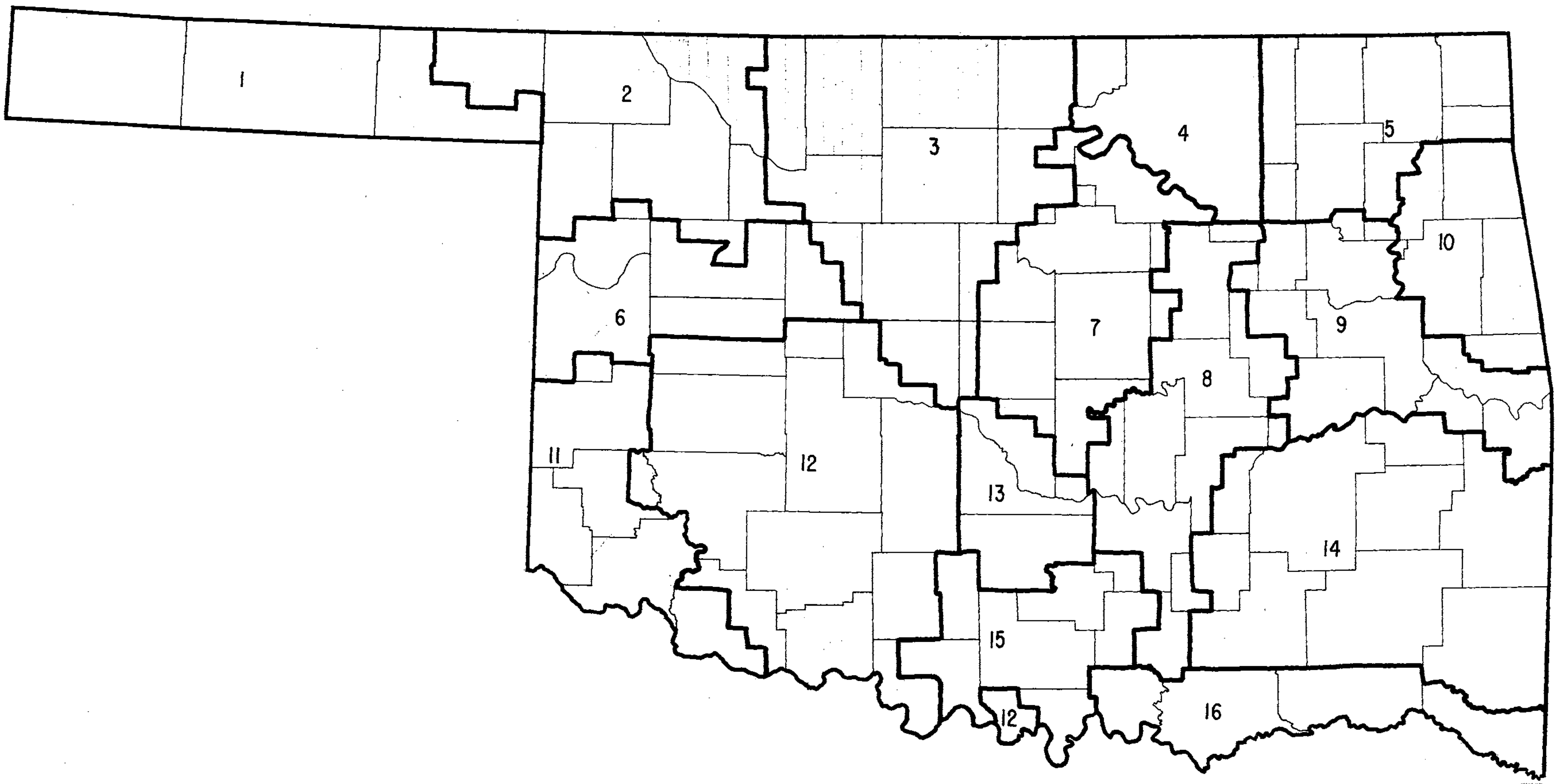

Figure 1. Preliminary Type of Farming Map of Oklahoma

Table 1

TYPE-OF-FARMING AREAS,

by Counties, Oklahoma.

Area and County	Description
Area 1 Beaver, Cimmaron, and Texas	Cash grain and livestock
Area 2 Ellis, Harper, Woods, and Woodward	Somewhat broken topography --some small grains, feed crops, livestock.
Area 3 Alfalfa, Canadian, Garfield, Grant, Kay Kingfisher, Major, and Noble	Cash grain, general farming
Area 4 Osage	Range livestock--some general farming.
Area 5 Craig, Mayes, Nowata, Ottawa, Rogers, Tulsa, and Washington	General farming, livestock, dairy, poultry and self-sufficing.
Area 6 Blaine, Custer, Dewey, and Roger Mills	Cash grain, general farming, cotton, livestock.
Area 7 Cleveland, Lincoln, Logan, Oklahoma, Pawnee, Payne, and Pottawatomie	General farming, cotton, livestock, dairy, and poultry.
Area 8 Creek, Hughes, Okfuskee, Pontotoc, and Seminole	Cotton, general farming, self-sufficing, dairy (an area of generally poor soil, except on small bottoms).

Table 1 Continued:

Area 9 Haskell, LeFlore, McIntosh, Muskogee, Okmulgee, Sequoyah, and Wagoner	Cotton, some dairy, potatoes, commercial vegetables, self-sufficing.
Area 10 Adair, Cherokee, and Delaware	Some fruit, general farming, dairy and poultry, self-sufficing (rough wooded land).
Area 11 Beckham, Greer, Harmon, Jackson, and Tillman	Cotton, supplemented with cash grain, livestock, dairy, and poultry.
Area 12 Caddo, Comanche, Cotton, Grady, Kiowa, Stephens, and Washita	Cottom, cash grain, livestock, some dairy and poultry.
Area 13 Garvin and McClain	Cotton, livestock, general farming, broomcorn.
Area 14 Atoka, Coal, Latimer, Pittsburg, and Pushmataha	Cotton, self-sufficing, livestock (rough, mountain and wooded area).
Area 15 Carter, Jefferson, Johnson, Love, and Murray	Range, livestock, general farming, self-sufficing.
Area 16 Bryan, Choctaw, Marshall, and McCurtain	Cotton, General farming.

dominance or influence, each township being assigned to one of the twelve urban centers. Townships were allocated to nearby urban centers upon the basis of two factors: population size of urban places and distance from urban places. For example, assume that several major cities encircle a particular township. Employing the population of each of the cities in the numerators, and the distance from each to the approximate center of the specified township in the denominators, separate indexes are computed. The generalized formula, which assigns townships to the city having the largest index (hence, influence upon the townships), is as follows:

$$\frac{P_1}{D_1^2} ; \frac{P_2}{D_2^2} ; \frac{P_3}{D_3^2} ;\ldots \frac{P_n}{D_n^2} \qquad (1)$$

where P_1 is the estimated 1945 population of city 1; D_1, the distance from township x to city 1; P_n, the estimated 1945 population of city n; and D_n, the distance from township x to city n.

Formula 1 assumes that the influence or dominance of a city over agricultural organization and rural-farm population in outlying areas is directly proportional to its size and inversely proportional to the square of the distance from it.

The study devises a modified method to determine the areas of dominance of Oklahoma's two metropolitan centers, Oklahoma City and Tulsa, over all 967 townships in the State. The mileage from each peripheral township to each of the two metropolitan cities was measured. Then, townships were allocated to one of the two cities, using the following formula:

$$X=R\ (D_1 + D_2) \qquad (2)$$

where X is a measure of the spatial domination or influence of the first of two competing centers, expressed in miles by the nearest highway; D_1 is the distance from the first of the two competing cities to township x; D_2, the distance from the second city to township x; and R is a dominance ratio (the relative influence which the first city extends over $D_1 + D_2$), being derived by the following formula:[3]

$$R = \frac{\frac{P_1}{P_2} - \sqrt{\frac{P_1}{P_2}}}{\frac{P_1}{P_2} - 1} \qquad (3)$$

where P_1 is an estimate of the 1945 population of the first city and P_2, an estimate of the 1945 population of the second major city.

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[3]Formulas 1, 2, and 3 assume that the influence which a trade and service center exercises over the outlying area varies directly with the population of that city and inversely with the square of the distance from it. In establishing the point of convergence between only two cities, one derives formulas 2 and 3 as follows:

where X = the distance from P_1 to the place where its influence ends, i.e., where the influence of P_1 and P_2 converge;

P_1 = the larger of two competing cities;

P_2 = the smaller city; and

D = the distance from P_1 to P_2;

assumption:

$$\frac{P_1}{X^2} = \frac{P_2}{(X-D)^2} \qquad (4)$$

Dividing by P_2 gives the following expression;

$$\frac{\frac{P_1}{P_2}}{X^2} = \frac{1}{(X-D)^2}$$

Fourth, after assigning each township to its dominant urban center using all twelve cities in one case and only the two Oklahoma metropolitan centers in the other case, the road distance separating the township from the dominant center was coded, along with the major city's code number and its population size.

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[3] (con't.) Solving for x gives,

$$X = D \left[\frac{\frac{P_1}{P_2} - \sqrt{\frac{P_1}{P_2}}}{\frac{P_1}{P_2} - 1} \right] \qquad (5)$$

However $D = D_1 + D_2$, since the distance between P_1 and P_2 is variable and changes with every peripherial township; And since the term is

$$\frac{\frac{P_1}{P_2} - \sqrt{\frac{P_1}{P_2}}}{\frac{P_1}{P_2} - 1}$$

a constant--it being the proportionate share of the total distance or area over which P_1 exercises a more dominant influence than P_2--one can substitute the symbol R for it. Thus,

$$R \ (D_1 + D_2) = D \left[\frac{\frac{P_1}{P_2} - \sqrt{\frac{P_1}{P_2}}}{\frac{P_1}{P_2} - 1} \right]$$

proving that formula 5 is equivalent to formula 2.

Fifth, from the 1945 Census of Agriculture, selected characteristics of the rural-farm population and of farms were coded for the computation of various indexes.

Sixth, productive man work units, calculated separately by type of farming area (Appendix A), were applied to crop and livestock data (Appendix B), to obtain the labor inputs of each township. The resulting measure of farm labor requirements indicates the farm work load in terms of ten-hour days, and is an index of the intensity of labor utilization in agriculture.

Seventh, by correlation analysis and other techniques, the study investigates the following ten land utilization and four demographic variables, by distance from urban centers:

A. Land utilization: (1) average size of farms; (2) number of acres of cropland harvested per 100 acres of land in farms; (3) value of land and buildings per 100 acres of land in farms; (4) value of land and buildings per capita; (5) number of acres of small grains harvested per 100 acres of cropland harvested; (6) number of cattle and calves, other than milk cows, per 100 acres of land in farms; (7) number of cows milked per 100 acres of land in farms; (8) number of livestock PMWU's per 100 acres of land in farms; (9) number of crop PMWU's per 100 acres of cropland harvested; (10) number of total (crop and livestock) PMWU's per 100 acres of land in farms.

B. Rural-farm population: (1) sex ratio; (2) per cent of rural-farm population under 14 years of age; (3) number of people per 100 acres of land in farms; (4) per cent change in the rural-farm population, 1940-50.

Hypotheses of the Study

This study analyzes the spatial distribution of Oklahoma farms and farm people, as well as certain characteristics thereof, in relation to proximity to major cities. Its three basic hypotheses are, first, that ten selective farm and four farm population characteristics vary uniformly with distance to the two Oklahoma metropolitan centers; second, that these fourteen selective features of farms and farm populations vary uniformly with distance within each major type of farming area; and third, that these fourteen traits vary uniformly with distance within each city-size class.

Since urban dominance diminishes as distance from major market centers increases, the foregoing hypotheses imply, first, that remoteness relates inversely to farm depopulation, directly to the sex ratio and to the percent of the total rural-farm population under 14 years of age, for birth rates rise as the degree of rurality rises; second, they signify that distance to urban places correlates directly with size of farms and inversely with farm population density; third, they indicate a concomitant variation between proximity and (1) the value of land and buildings per 100 acres of land in farms; (2) the number of acres of cropland harvested per 100 acres of land in farms; (3) the number of cows milked per 100 acres of land in farms; (4) the number of crop, livestock, and total productive man work units per 100 acres of land in farms; and (5) the number of crop productive man work units per 100 acres of cropland harvested; and fourth, they suggest a direct association between distance and (1) the per capita value of land and buildings; (2) the number of cattle and calves, excluding milk cows, per 100 acres of land in farms; and (3) the number of acres in small grains per 100 acres of cropland harvested.

CHAPTER II

Review of Literature

Social scientists have undertaken comprehensive studies of the composition and distribution of rural-farm population and agricultural land use patterns in relation to distance from urban centers, employing theories of agricultural location, metropolitan dominance, and a hierarchy of central places. First, they used historical and geographic inference, later quantification, in any case using the most highly responsive and selective analytical instruments and techniques then known.

Agriculture Location

A German writer, Johann Heinrich von Thünen (1783-1850), was the first economic theorist to concern himself with the influence of distance upon markets as related to the structure of agriculture. His main work appeared in full in 1863, thirteen years after his death. His principle of the Isolated State is an hypothetical and deductive determination of the utilization of land as influenced by forces operating in a vacuum. In order to segregate the influence of location of the utilization of the soil he conceived a large city in the center of a fruitful plain, assuming all physical conditions of the plain to be the same. Also, he assumed a plain containing no navigable stream or canal. Thus soils, rainfall, temperature, or any other physical factors would not contribute to differences in crops and methods of farming. Rather, the differences would be attributable purely to the economic factor of distance from the market.

Von Thünen conceived hypothetically a city with a series of rings around it. Beyond the outermost ring was a wilderness separating the Isolated State from the rest of the world. The one large city was the source of manufactured products for the State. The country was the only source of food for the State. Thus, Von Thünen's Isolated State was self-sufficient.

Von Thünen was both an economist endeavoring to depict the Ideal State and a practical farmer concerned with the most advantageous uses of his land. To arrive at his conclusions he used accounts from his own estate, Tallow. He asked, "How would I manage my estate were it located at some particular spot in this State? What economic effects would I experience if I moved my farm toward the periphery of this hypothetical State, or nearer to the city?"[1]

He further contended that land utilization under the Isolated State would adjust itself to economic rather than natural conditions. This would lead to uniform types of agriculture which would be outlined by "rings or zones." Competition explains the order by which the different rings would surround the city.

According to his scheme seven "Zones" would be formed. Ely and Wehrwein in an early publication of their Land Economics explained these seven zones of agriculture.[2]

Zone One would be one devoted to perishable crops, such as fruits, berries, gardens, and whole milk. Zone Two would be forests for building purposes and fuel. In America natural forests might not necessarily

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[1]Richard T. Ely and George S. Wehrwein, Land Economics (New York, 1948), p. 66, from which source the foregoing statement is quoted.

[2]Richard T. Ely and George S. Wehrwein, Land Economics (Ann Arbor, 1928), pp. 44-47.

be found in Zone Two; however, when new forests were planted they would probably be located in Zone Two, due to economic reasons. In Europe, where forests are planted, they would be in Zone Two.

Zone Three would consist of a "grain rotation culture." In this zone grain and leafy plants would be grown. Pasture and fallow would be found in Zone Four, with the "ancient 3 field system" of barley, fallow, and rye in Zone Five, the "zone of cereal culture."

Von Thünen noted that there would be no production of grain beyond 31.5 miles from the city. Also, he noted that Zones One and Three would be areas of intensification. However, within each zone, as one moved away from the point nearest the city to the next zone, the type of agriculture would change from high to low intensification.

In Zone Six there would be cattle raising, consisting mainly of beef animals because they could be driven to market, thus reducing transportation costs. However, a few milk cows would be in this area, their products being used for the production of butter. Butter would be produced because it is high in value and small in volume, thus facilitating its transportation. Only hunting would be carried on in Zone Seven, with the pelts being transported to market. These pelts have a high value and would be easy to transport.

After studying the economic effects of varying the location of his farm in the various parts of the Isolated State, Von Thünen introduced the navigable river. He found that shipment by water reduced transportation costs to one-tenth that of land transportation. Thus, each circle along the stream would extend ten times the distance of the circle located where there was no navigable river. The construction of improved roads would have similiar effect as that of a navigable river, for when "...roads radiate in various directions the circles become star shaped, a fact noted very often in connection with the development of cities."[3]

When a small city is located some distance away from competing places it tends to develop its own circle of influence. The larger the city the greater is the intensity and range of its influence on land utilization. However, the city would still regulate the prices of agriculture commodities.

In studying the influence of the metropolitan centers over their satellites, McKenzie[4] corroborates these assertions in the following statements:

> In other words, the satellite centers tend to limit the competition and relative independence of their small subsidiary towns in about the same way that the metropolis tends to limit the competition between satellites. As supplementary forms of communication and transportation develop in the metropolitan area to a point where the system is completely flexible, we should expect the importance of the satellite to diminish even more.[5]

Figure 2 applies Von Thünen's agriculture location theory using a hypothetical example. This illustration considers four agriculture commodities, milk, watermelons, wheat, and beef cattle. Utilizing a given per unit cost of transporting, Figure 2 plots the economic margin, the margin of transference, and the margin of no rent for each of the four commodities, showing the distance that each activity would be carried on from the market center (see Appendix C).

Rent, in this instance, is "economic rent" rather than the usual conception, which includes only that payment to a landlord for the

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[3]Ibid., p. 47.

[4]Roderick Duncan McKenzie, The Metropolitan Community (New York, 1933), pp. 98-110.

[5]Ibid., p. 105.

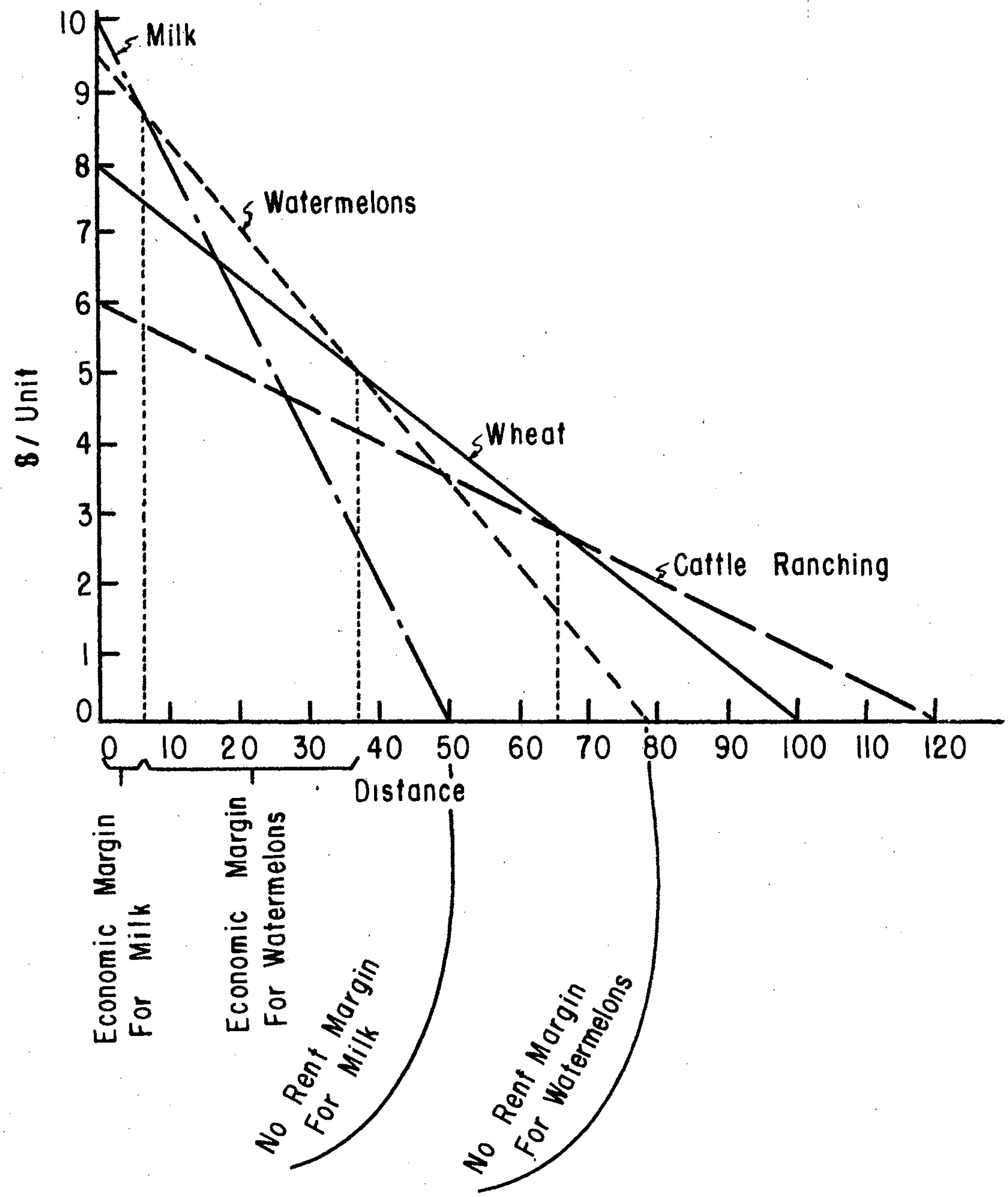

Figure 2. Hypothetical Example of Von Thünen's Rent Theory -- its Affects on the Location of Resources.

use of a house, land, and so on. The term "economic rent," as stated by Thomas Robert Malthus, is as follows:

> The rent of land may be defined to be that portion of the value of the whole produce which remains to the owner of the land, after all the outgoings belonging to its cultivation, of whatever kind, have been paid, including the profits of the capital employed, estimated according to the usual and ordinary rate of the profits of agricultural capital at the time being.[6]

In this hypothetical example, milk returns the greatest economic rent of all commodities from the city to seven miles out. From eight to thirty-seven miles, watermelons return the greatest economic rent. From thirty-eight to sixty-seven miles, the greatest economic rent comes from wheat production and from sixty-eight to one hundred eighteen miles cattle production or ranching returns the greatest economic rent.

The transference margins for the four commodities occur at the following locations: At a distance of six to seven miles from the market center the economic rent for watermelons rises above that for milk. At a distance of thirty-seven to thirty-eight miles the economic rent of wheat surpasses that for watermelons and at a distance of sixty-seven to sixty-eight miles the economic rent for cattle ranching exceeds that for wheat.

As distance from the nearest urban center increases, the cost of moving the commodities from the farm to the consuming center rises. Theoretically, at some distance point for each commodity, shipping costs and net profits coincide. At this specific distance, the producer just breaks even because returns and cost are equivalent; therefore, the economic rent is zero. In the hypothetical example employed here,

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[6]Thomas Robert Malthus, The Principles of Political Economy (2nd ed. London, 1936), p. 136.

the zero or no rent margins for the following four commodities occur at the following points from the consuming center: milk, fifty miles; watermelons, seventy-nine miles; wheat, one hundred miles; and cattle production or ranching, one hundred and twenty miles (Appendix C).

What effect does an expanding city have on the economic rent margins of these four particular agricultural products? First of all, the land upon which city expansion takes place undergoes an increase in per acre value. The following quotation substantiates this result; also it indicates the direct connection between the increasing land values and agricultural land utilization:

> The expenses of production of oats are increased by the fact that land, which could yield good crops of oats, is in great demand for growing other crops that enable it to yield a higher rent... Again a hop-grower may find that on account of the high rent he pays for his land, the price of his hops will not cover their expenses of production where he is, and he may abandon hop-growing, or seek other land for it; while the land he leaves may perhaps be let to a market-gardener. After a while the demand for land in the neighborhood may again become so great that the aggregate price which the market-gardener obtains for his produce will not pay its expenses of production, including rent; and so he in turn makes room for, say, a building company.
>
> In each case the rising demand for land alters the margin to which it is profitable to carry the intensive use of the land; the cost at this margin indicates the action of those fundamental causes which govern the value of the land. And at the same time they are themselves those costs to which the general conditions of demand and supply compel value to conform and therefore it is right for our purpose to go straight to them; though any such inquiry would be irrelevant to the purposes of a private balance sheet.[7]

Arnold and Montgomery applied Von Thünen's principle in their study of the influence of Louisville, Kentucky, on agriculture in Jefferson County, Kentucky.[8] The purpose of their study is stated as follows:

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[7]Alfred Marshall, Principle of Economics (8th ed. New York, 1948), pp. 450-451.

[8]J. H. Arnold and Frank Montgomery, "Influence of a City on Farming," United States Department of Agriculture Bulletin, No. 678, 1918. pp. 1-24.

[To] analyze conditions [agriculture] in order to arrive at an understanding of the underlying principles of farm organization and practice here [Jefferson County, Kentucky], to point out the more profitable types of farming, and to show how some of the more successful farms are organized.[9]

They report that distance has an important bearing on the type of farming. Their findings indicate that truck crops and potatoes are dominant enterprises near the city; that enterprises of a more general mixed nature become more predominant as distance from the city increases. Farms increase in size but economic rent per acre decreases as the distance from the city increases. From 0-8 miles from Louisville the value of land was $312 per acre, decreasing to $95 per acre at a distance of over 14 miles.

Hierarchial Arrangement of Central Cities

Many establishments providing goods and services have direct contact with consumers. Those firms supplying services which individuals demand constantly would tend to locate in the midst of their customers. This would be particularly true of those supplying convenience goods and essential day-to-day services to the inhabitants of a locality.

Walter Christaller, a German scholar, developed a theory of a hierarchy of central places which serve as trade and service centers, with the centers being tied together in one vast administrative and inter-dependent region. Christaller's "law of central places" postulates a uniformity of soil characteristics and population size of various places, with traffic routes from the outlying hinterland converging

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[9] Ibid., p. 2.

radially at its center. On this vast uniform plain is a systematic arrangement of central places, each spaced regularly in a radial-circular system, but varying in size, function, and a spatial location. Except for the largest capital city (Landeshauptstadt), all centers fall within the tributary areas of larger sized centers, regularly spaced but at greater distances.[10] Thus, a hierarchial system of governmental and trade and service centers, each with its own tributary area, occurs in an interlocking locational pattern. Moreover, each central place has a definite functional relationship with the other centers, both the smaller places within its orbit and the contiguous larger cities.

In addition, each market place has a hexagon-shaped trade area which borders the trade areas of six equidistant and equal size centers. Consequently, costs of moving farm commodities to the local market increase as one goes outward from the center. The following excerpt from Dickinson details this pattern more fully:

> Working on a theoretical basis, and taking the market town with a service radius of 4 km. (2 1/2 miles) as the unit area, he [Christaller] has drawn up a scheme of distribution of centralized services which, he [Christaller] shows, is closely borne out by the facts of town size and distribution in south Germany. Theoretically, in respect of centralized services, a town should serve a circular area. But towns with the same service status will be equally spaced from it and from each other, and will compete with each other in their intersecting border zones where centers of lower status can supply certain local services more efficiently than the centers of higher order. Thus, a center of higher order will be surrounded on the periphery of its service area by six equally spaced centers of a lower order. These six centers of a lower order will be equally spaced from each other, and from the town in the center. On this theoretical basis, towns will be equally spaced, in different orders, with hexagonal-shaped market areas.
>
> Christaller noted that the concentration proceeds in steps, from

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[10] Edward Ullman, "A Theory of Location for Cities," American Journal of Sociology, 46 (May, 1941), pp. 853-864.

which there may be recognized towns of several orders. The smallest seats of centralization are the urban villages and the market towns.[11]

The theory of a hierarchial system of central places is consistent with ecological theory, for one of the basic premises of each is that of functional interdependence. Indeed, one of the principal presuppositions of the "law of central places" is a highly integrated economy and set of political institutions throughout the hypothetical region.

Although the number of inhabitants varies systematically in this hypothetical model by the hierarchial order of the central places, the relative distribution of the farm population is apparently indeterminate.[12] Moreover, the agricultural land use patterns are somewhat indeterminate in this hypothetical pattern, for one cannot establish the precise influence of central places upon farm sizes and land uses, by proximity to various centers. Perhaps each of the adjacent central places of varying orders with hexagonal tributary areas exert a differential influence upon agriculture.

Metropolitan Dominance and the Ecological Aspects of Land Use

Duncan studied the dwindling influence of urban centers on the rural population, employing the hypothesis "that the rural population in areas under the immediate influence of urban centers differs systematically from the rural population in areas somewhat remote from these centers." [13]

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[11] Robert E. Dickinson, City Region and Regionalism (London, 1956), pp. 30-31.

[12] From published materials it is impossible to ascertain whether Christaller assumed that farmers resided in nucleated settlements, whether they were uniformly dispersed on farmsteads, or whether population density dwindled with distance from the nearest center, thus conforming to the assumptions embodied in Von Thünen's Isolated State.

[13] Otis Dudley Duncan, "Gradients of Urban Influence on the Rural Population," The Midwest Sociologist, 18 (Winter, 1956), pp. 27-30.

In testing this hypothesis he classified the counties of the United States according to their presumed degree of urban influence; he then analyzed the demographic differences among the categories of his classification system. Counties were classified as "metropolitan" when completely or partly inside a Standard Metropolitan Area or "non-metropolitan" when completely outside a Standard Metropolitan Area. Metropolitan counties were divided into those which the central urbanized areas exceeded a quarter of a million population and those with less than a quarter of a million population. Non-metropolitan counties were divided into those which the largest place in the county exceeded 25,000 population and into those with less than 25,000 population.

The major findings of this study are as follows: The age-sex structure of both the rural-nonfarm and rural-farm populations respond to urban influence. In the least urban counties the rural-nonfarm age-sex pyramid resembles that of the village population, with its relatively high proportion of old people and low proportion of young adults. When compared with the pyramid for the rural-farm population in the least urban counties, the rural-farm pyramid in the urban counties has a high proportion of old adults and low proportions of children and youth. Moreover, farm and rural-nonfarm fertility ratios increase as one moves from the most to the least urban counties. Duncan concludes that the gradient of urban influence is, in most respects, more pronounced for the rural-farm than for the rural-nonfarm populations. Also, the gradient of urban influence is steeper in least urbanized geographic areas..

Brunner and Kolb found that cities exercise a decisive influence over surrounding farming areas.[14] Using 18 medium-sized centers scat-

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[14]Edmund de S. Brunner and J. H. Kolb, Rural Social Trends (New York, 1933), pp. 111-126.

tered throughout the United States, they plotted concentric zones on a county basis. All counties bordering each city were designated Tier One; all counties bordering on Tier One were called Tier Two, and so on.

For this study 347 counties were used, averaging approximately 19 counties to each center. Counting the cities, 10.2 per cent of the population in the entire nation was in the sample.

Brunner and Kolb's study confirms the gradient of urban influence, for they found that distance from the city relates directly to the fertility ratio. Fertility is lowest in the counties containing the cities; it rises in the Tier One counties, and progressively increases as one goes outward.

Also, this study shows that the ratio of children under 10 to women 20-45 years of age is higher on farms than in rural-nonfarm areas. The number of males to 100 females increases as one moves away from the urban center. The average area of improved land increases with distance; improved farm land acreage decreases outward, indicating a more extensive use of land with increasing remoteness.

When considering the location of various types of farming, Brunner and Kolb found that fruit, milk, and poultry farms were located mainly in the county containing the city and in the Tier One Counties. Dairy farms increased steadily outward to Tier Four Counties where they dropped sharply. Although animal specialty farms were somewhat more numerous in the county containing the city than in the other counties due to part-time farming, they increased from Tier One outward. In concluding their study, Brunner and Kolb make the following statement:

It seems abundantly evident from these data that agriculture is not a unit, but is variously influenced not only by soil, climate, and rainfall, but also by markets as determined by the location of cities and the proximity of farms to cities.[15]

Another study comes to approximately the same conclusion, finding that metropolises exercise dominance over the outlying area.[16] According to Bogue, the degree of dominance is a function of (a) distance over standard highway routes; (b) the type of sector; (c) the size of the metropolitan center; and (d) the size of the hinterland or subdominant city.

In making his study, Bogue divided the entire area of the United States into sixty-seven metropolitan area regions. Finally, classifications of distance, sector, the size of the metropolitan community, and the size of the largest city in each county were coded. He then explored the patterns of dominance, using these four variables. He describes the interworking patterns of dominance and subdominance in the following manner:

> The rural populations adapt to conditions associated with both hinterland cities and metropolitan centers. Hinterland cities adapt to conditions associated with the presence of other hinterland cities larger than themselves and to the presence of the metropolis. The evidence presented here indicates most clearly that the distribution of population and of sustenance activities in the metropolitan community cannot be understood without reference to the influence of the individual hinterland city, just as the influence of the individual hinterland city cannot be understood without reference to the influence of the nearest metropolis. The metropolitan community thus appears to be an organization of many mutually interdependent and interfunctioning sub-communities oriented about the hinterland cities, which, in turn, are subdominant to and interdependent with the dominant metropolis, and interfunction with it. The entire community organization appears to be held together by a system of community specialization in, and exchange of, locally produced surpluses to fill those needs which cannot be most efficiently satisfied by local institutions.[17]

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[15] Ibid., p. 125.

[16] Don J. Bogue, The Structure of the Metropolitan Community. (Ann Arbor, Michigan, 1949), pp. 3-143.

[17] Ibid., p. 59.

Still another study examines the relationship between fertility in rural areas and distance to cities, using data from sixteen groups of rural townships around eleven large cities of the United States.[18] One group of townships was in the Middle Atlantic, three in the East North Central, three in the West North Central, three in the South Atlantic, three in the West South Central, and three in the Pacific states.

The measure of fertility employed in the study was the number of children under 5 years of age per 1,000 persons 15-44 years of age in 1930. The following factors were studied: distance from the township to the city; the percentage of the farm land in crops; the average value of farm land and buildings per acre; the proportion of the rural population living on farms, the ratio of rural persons 25-34 to those rural persons 15-24 years of age, the rural sex ratio and the number of proportionate native whites in the rural population.

Thompson and Jackson did not find a consistent gradient of influence extending out from urban centers, for they note that:

> No two areas present identical pictures of the relationship between fertility, as measured by the ratio of children under 5 to persons 15-44, and the seven factors selected to measure the degree of isolation from urban influence, the economic status of the family, and the demographic characteristics of the population. Even when two areas extending out from the same city are compared, they are found to differ in many respects, and the age-old acceptance of urban influence on fertility is somewhat discredited in a few areas.[19]

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[18] Warren S. Thompson and Nelle E. Jackson, "Fertility in Rural Areas in Relation to Their Distance From Cities," Rural Sociology, 5 (June, 1940), pp. 143-162.

[19] Ibid., p. 144.

Finally, two further studies relating to the spatial organization of rural areas provide additional evidence of the ecological hypothesis of metropolitan (or urban) dominance. First, a study conducted in Canada reveals that the rural family increases in size as distance from the metropolis increases.[20] Second, a study of Missouri counties establishes an inverse relationship between the farm-operator family level-of-living index and distance from urban centers and a direct association between farm size and distance within the Corn Belt of that state.[21] Nevertheless, this latter study questions the plausibility of the hypothesis of metropolitan dominance and/or urban dominance, giving departures from that concept. Furthermore, this paper suggests that gradients are the results of various factors, only some of which are metropolitan in origin. Hence, not all the gradient pattern emanates from metropolitan or urban dominance.

Interrelationships Among the Three Foregoing Conceptual Formulations

Christaller's "law of central places" posits an economically and politically interdependent system of regularly spaced trade and service centers in a broad uniform region, with roads radiating outward from its center like spokes in a wheel. Consequently, it is possible to relate the ecological aspects of Christaller's model with those in the hypothesis of metropolitan dominance.

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[20] Nathan Keyfitz, "A Factorial Arrangement of Comparisons of Family Size," American Journal of Sociology, 58 (March, 1953), pp. 470-480.

[21] Theodore R. Anderson and Jane Collier, "Metropolitan Dominance and the Rural Hinterland," Rural Sociology, 21 (June, 1956), pp. 152-170.

In examining the relationships between the ecological theory of metropolitan dominance and the economic theory of location, Jorgenson indicates that the concepts of human ecology refer to the same objects as those in location theory.[22] Moreover, he shows that the formal structures (operations linking the objects) of ecological theory and locational theory are similar. In addition, Jorgenson concludes that the concept of metropolitan dominance is less adequate than the fully formalized economic theory of location in explaining the location of population and economic activity. Whereas the former is a rather generalized theoretical formulation of human ecology, without precise mathematical statements of relations, the latter theory postulates the maximization of profit and analytically specifies its component parts in a measurable fashion.

Previous research shows that many factors determine agricultural land uses and the distribution of farm people. For example, Hawley indicates that human activities follow an orderly arrangement in space, being distributed about given points because of certain fundamental life conditions.[23] These conditions include the interdependence among men, the dependence of activities upon various characteristics of land, and the friction of space.[24] The first two conditions account for the development of the pattern; the third explains the size and shape of that pattern. Each of the factors is, in turn, dependent upon the other two.

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[22]Dale W. Jorgenson, Location Theory and the Hypothesis of Metropolitan Dominance (B. A. thesis, Reed College, 1955)

[23]Amos H. Hawley, Human Ecology (New York, 1950), p. 234.

[24]Friction of space may be expressed as that which must be overcome in order to move from place to place. Thus, it would include not only distance but also the quantity and volume of physical objects.

The interdependence of men and their dependence upon land tend to exert opposite distributive and locational influences. One leads to the compact settlement, the other leads to the dispersion and scattered settlement. The interdependence among men requires that individuals and communities be in relatively close proximity. Those highly dependent upon others for daily services and those who exchange services frequently must be closer together than those less dependent.

Each economic activity or service has its own requirements relative to the amount and type of space that it occupies. Since agriculture employs large quantities of land, it usually has a peripheral location. Nevertheless, agriculture benefits when it is located near urban centers. However, its dependence upon certain soil types restricts its location. Therefore, while its interdependence (also its consumption center) necessitates at least some degree of proximity, that proximity is limited by the various competing uses of land. The friction of space partially explains the spatial organization of farm people.

Yet, one must traverse through space in order to ship farm commodities to market centers. This physical movement requires some expenditure of time and energy. Mountains, streams, other types of topography, air currents, and man-made structures which come in the line of travel or agriculture movement may increase or decrease the friction of space. The degree of friction in space is thus dependent not only on the physical distance but also on the volume or quantity of physical objects present. In so far as it enters into human activities and relationships, distance is entirely relative to the available techniques for overcoming the friction of space. Improvements in communication and transportation reduce costs and travel time, thus permitting the people to spread over a wider area without losing contact with each other.

Thus, the ability of movement among humans and human activities affect the amount of diversification within any given area. As the ratio of time and expenditure per mile of movement increase in any given area, the number of people the area supports progressively dwindles. Therefore, an increase in travel or shipping costs restricts the activities and number of farm people in an area. When improved methods of communication and transportation reduce the friction of space an area's population and economy can then expand and specialize.

CHAPTER III

Findings of the Study

In testing the hypotheses stated in Chapter I, the study examines ten farm and four population variables by distance from major cities, by city size, and by type-of-farming area (Table 2). In general, the findings are consistent with the hypotheses, indicating significant associations between distance and the distribution and characteristics of farms and farm people. Nevertheless, some findings fail to support the hypothesized relationships.

Size of Urban Center

Figure 4 allocates the 967 Oklahoma townships to one of the twelve major urban centers and Table 3 summarizes the coefficients of correlation between distance from the township to the dominant city and each of the fourteen population and farm variables.

For the entire state the association between proximity and average size of farms is rather high, the coefficient of correlation being .51. Nonetheless, the relationship between proximity and farm size (X_2) is inverse in four of the twelve city regions, Muskogee, Dallas, Amarillo, and Denver. Also, the coefficients of correlation between distance and each of the other thirteen variables are direct in some city areas and inverse in other city areas (Table 3). Hence, the correlation ratios reveal a lack of uniformity in variation with distance within the areas of influence of each of the twelve cities.

Table 2

IDENTIFICATION OF THE 15 VARIABLES

X_1 - Distance

X_2 - Average size of farms

X_3 - Number of acres of cropland harvested per 100 acres of land in farms

X_4 - Value of land and buildings per 100 acres of land in farms

X_5 - Value of land and buildings per capita

X_6 - Sex ratio

X_7 - Per cent rural-farm population under 14 years of age

X_8 - Number of farm people per 100 acres of land in farms

X_9 - Number of acres of small grains harvested per 100 acres of cropland harvested

X_{10} - Number of cattle and calves, other than cows being milked per 100 acres of land in farms

X_{11} - Number of cows milked per 100 acres of land in farms

X_{12} - Livestock PMWU's per 100 acres of land in farms

X_{13} - Crop PMWU's per 100 acres of cropland harvested

X_{14} - Total PMWU's per 100 acres of land in farms

X_{15} - Per cent change in rural-farm population 1940-50

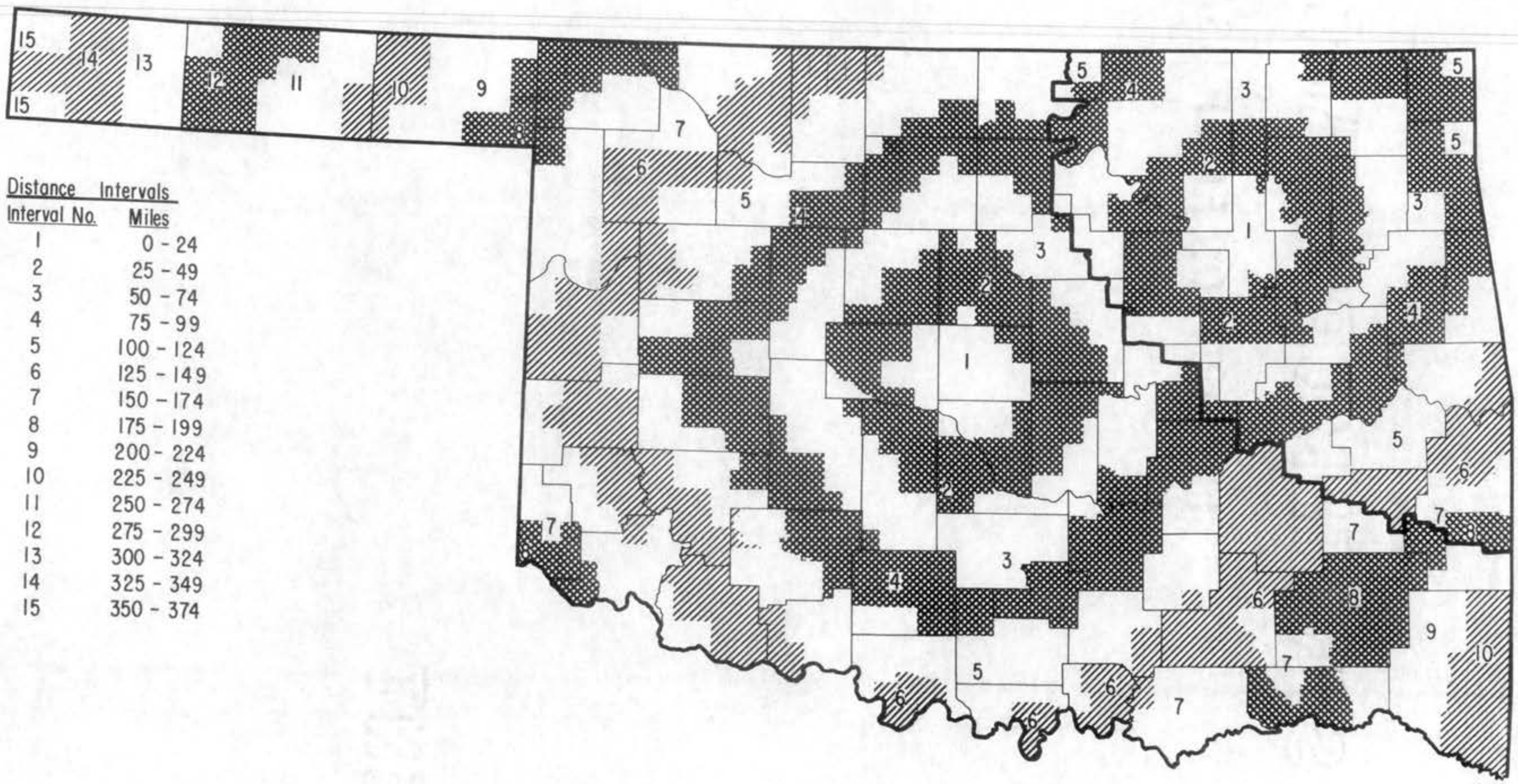

Figure 3. Allocation of Townships to Oklahoma City and Tulsa

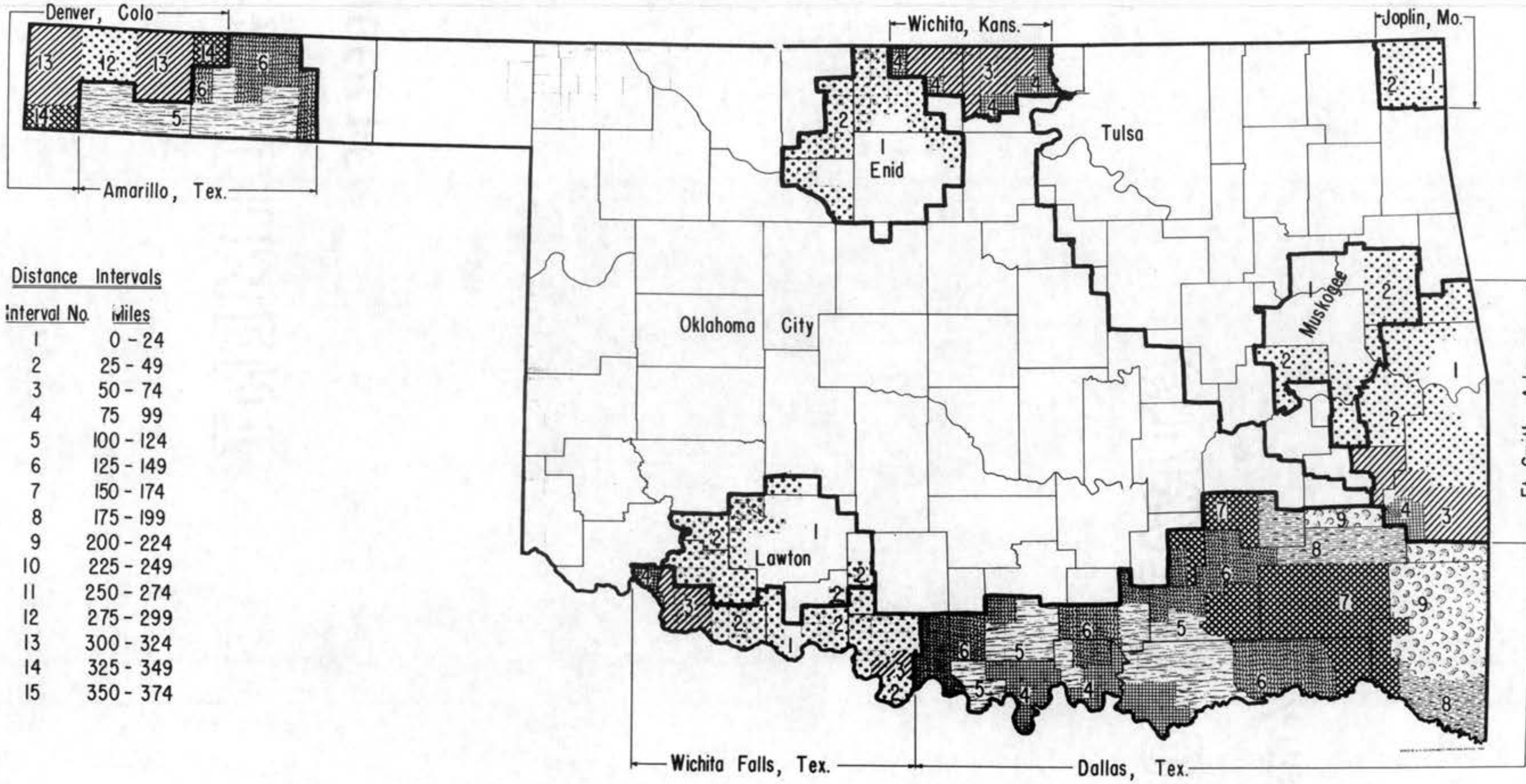

Figure 4. Allocation of Townships to the 12 Urban Centers

Table 3. Coefficients of Correlation Between Distance and Each of the Fourteen Variables, by the Twelve Major Urban Centers*

Urban Center	Number of Towns.	Variable Number **													
		X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
Total, All Townships	967	.51	-.09	-.33	.19	.06	-.05	-.37	.24	-.10	-.51	-.42	-.19	-.38	.08
Okla. City	521	.57	.03	-.34	.31	-.04	-.09	-.54	.44	-.05	-.65	-.67	-.35	-.52	.14
Tulsa	149	.09	-.25	-.43	-.04	.21	-.02	-.12	-.12	.01	-.26	-.16	-.07	-.22	.11
Denver	7	-.59	.53	.44	-.17	.24	.42	.62	.49	-.55	.90	.55	-.06	.62	.72
Dallas	66	-.22	-.37	-.33	-.47	-.09	.27	.49	-.31	.55	-.10	.50	-.15	.08	.33
Wichita	19	.05	-.45	-.39	-.19	.26	.14	.01	-.26	-.06	.18	.18	.47	.23	-.25
Amarillo	16	-.15	.42	.51	.09	-.10	-.07	.36	.13	.20	.26	.07	-.19	.41	-.04
Wich. Falls	20	.05	.13	.53	.29	.26	-.38	.20	-.33	.11	-.39	-.35	.51	.52	.55
Ft. Smith	47	.03	-.32	-.35	-.33	.29	-.07	-.15	.20	.56	-.25	.30	-.30	.03	.07
Joplin	7	.58	.68	.01	.39	-.11	-.63	-.63	.14	-.41	-.49	-.40	-.22	-.18	-.61
Muskogee	29	-.05	-.58	-.62	-.70	.15	.10	-.02	-.35	.09	-.38	-.32	.34	-.31	.19
Enid	55	.39	-.34	-.55	-.13	.01	.02	-.49	-.14	-.16	-.50	-.50	-.05	-.62	.00
Lawton	31	.18	.28	.29	.50	.46	.17	-.21	-.12	-.23	-.59	-.60	.50	.15	.08

* Distance is the highway mileage from each township to the nearest dominant urban center (See Figure 4 for the twelve urban regions in Oklahoma).

** Numbers correspond with the variables listed in Table 2.

According to the analytical models of this study, market centers exert an influence upon ecological patterns in outlying areas in direct proportion to their population size. Hence, the gradients of influence would be more pronounced and would extend farther for large than for small market centers. Therefore, in the immediate vicinity of urban centers, one expects that farms will decline in size, land uses will intensify, and farm population density will climb, all proportionately, with increasing size of cities.

Theoretically, farms near cities should decline in size as the population of centers increases; conversely, farm population density and the number of dairy animals per acre should increase in the vicinity of cities as population increases. Evidently the population size of the dominant urban center bears little relationship to farm size and population density. Dairy animals do not vary uniformly by city size within each distance interval; nor do any of these three factors change uniformly with distance within each of the twelve city regions (Table 4). Therefore, the size of the city fails to generate significant differentials in population and farm land use patterns, by distance (See Appendix Table E for the other eleven variables).

Type of Farming Area

The study posits a consistent variation in population composition and in agricultural land utilization patterns with proximity within each type of farming area. Since each of the sixteen type of farming areas is presumable homogeneous, one expects farm size to enlarge progressively with distance in each area. However, farms dwindle in size (X_2) in six of the sixteen type of farming areas with the coefficients of correlation being -.11 for type of farming area 4, -.22 for area 8, -.25 for area 9,

Table 4. Average Size of Farms, Number of Farm People, and Number of Cows Being Milked, by Distance Intervals from each of the Twelve Major Urban Centers.*

	Average	Highway Mileage													
Total All		0-24	25-49	50-74	75-99	100-24	125-49	150-74	175-99	200-24	225-49	250-74	275-99	300-24	325-49
Townships	311	197	219	213	259	391	422	566	507	701	767	758	1,656	2,351	1,636
		Size of Farm (X_2)													
Denver	2,187												2,636	2,351	1,636
Dallas	181				162	173	231	177	143	86					
Okla.City	333	137	221	209	263	317	393	658	603	1,213	767	758	676		
Tulsa	219	194	208	212	272	258	106								
Wichita,K.	259			256	263										
Amarillo	1,278					1,358	1,198								
Wich.Falls	336	282	338	352	293										
Ft. Smith	112	115	112	108	131										
Joplin, Mo.	136	103	141												
Muskogee	122	130	114												
Enid	279	262	297												
Lawton	320	298	362												
Total All		Number of Farm People (X_8)													
Townships	2.0	2.9	2.3	2.2	1.9	1.6	1.3	1.2	1.3	2.5	.5	.5	.3	.2	.3
Denver	.2												.1	.2	.3
Dallas	2.6				2.4	2.5	2.0	2.6	3.8	4.9					
Okla.City	1.8	3.8	1.9	3.0	1.7	1.4	1.1	.8	.7	.4	.5	.5	.4		
Tulsa	2.7	3.6	2.5	2.5	2.7	2.7	2.6	3.6							
Wichita,K.	1.3				1.4	1.3									
Amarillo	.3						.3	.4							
Wich.Falls	1.3	1.3	1.3	1.4	1.4										
Ft. Smith	4.2	4.3	4.2	4.2	3.0										
Joplin, Mo.	2.9	3.5	3.8												
Muskogee	3.8	3.7	4.0												
Enid	1.3	1.4	1.1												
Lawton	1.4	1.5	1.2												

* Distance is the highway mileage from each township to the nearest dominant urban center (See Figure 4 for the twelve urban regions in Oklahoma).

Table 4. Continued:

	Average	Highway Mileage													
		0-24	25-49	50-74	75-99	100-24	125-49	150-74	175-99	200-24	225-49	250-74	275-99	300-24	325-49
		Number of Cows Being Milked (X_{11})													
Total All Townships	2.0	2.8	2.1	2.2	2.0	1.7	1.4	1.2	1.1	1.1	.6	.5	.2	.2	.2
Denver	.2												.1	.2	.3
Dallas	1.7				1.7	2.0	1.6	1.5	1.7	1.9					
Okla.City	1.9	3.3	2.2	2.3	2.0	1.8	1.5	1.1	1.0	.5	.6	.5	.3		
Tulsa	2.4	3.4	2.3	2.3	2.1	1.9	2.0								
Wichita,K.	1.9			1.8	2.0										
Amarillo	.3					.3	.3								
Wich.Falls	1.1	2.0	1.2	.7	1.0										
Ft. Smith	2.4	2.4	2.5	1.8	1.9										
Joplin Mo.	3.4	4.8	3.2												
Muskogee	2.8	3.1	2.6												
Enid	2.0	2.3	1.8												
Lawton	1.7	2.1	1.1												

-.19 for area 10, -.39 for area 14, and -.73 for area 16 (Table 5). Moreover, farm population density (X_3) rises with increasing distance in five of the sixteen areas; the number of cows milked per 100 acres of land in farms (X_{11}) increases with distance in three areas; and the number of productive man work units (X_{14}) advances directly with distance in four type of farming areas (Table 5).

The size of the coefficients of correlation between accessibility and each of the fourteen farm and population items fluctuates considerably from one type of farming area to another. Furthermore, on each variable the signs of the coefficients are positive for certain types of farming areas and negative for other areas. Even though the relationships between proximity and each of the fourteen variables in most types of farming areas coincide with the statewide configurations, those for areas 4, 10, 14, and 16, in particular, and areas 8 and 9, to a lesser extent, diverge substantially. In some cases these discrepancies probably arise from faulty type of farming area delineation; in other cases they probably are the result of erratic fluctuations of the variables.[1]

Table 6 shows the precise association between proximity and average farm size, by type of farming area, in the entire State. The Oklahoma

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[1]One notable misclassification occurs in type of farming area 4, which is predominantly one of range livestock with some general farming. Six of the townships located in this area show considerable variation in the per cent of cropland harvested. Three townships located in the northeastern part of Kay County have relatively large acreages of crop production: in Beaver township seventeen per cent of all cropland was harvested in 1944, in Kaw township 25 per cent, and in Walham township 49 per cent. On the other hand, three contiguous townships in Osage County have rather small acreages in cropland: in Bighill township only 8 per cent of its land was in harvested crops, in Fairfax only 9 per cent, and in Foraker only 7 per cent. These contrasting proportions indicate clearly that the first three townships belong in type of farming area 3, which is cash grain and general farming rather than in Area 4, which is range livestock and general farming.

Table 5. Coefficients of Correlation Between Distance and Each of the Fourteen Variables, by Type of Farming Area, Oklahoma.*

Type of Farming Area	Number of Towns.	Variable Number **													
		X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
Total, All Townships	967	.51	-.09	-.33	.19	.06	-.05	-.37	.24	-.10	-.51	-.42	-.19	-.38	.08
1	39	.67	-.30	-.43	.12	.01	.07	-.71	-.30	-.68	-.75	-.78	.57	-.72	.48
2	68	.34	-.06	-.21	.37	.07	.01	-.59	.37	-.05	-.66	-.67	-.38	-.58	.07
3	172	.24	.24	-.06	.29	-.21	-.25	-.26	.30	.03	-.37	-.39	-.43	-.40	-.02
4	13	-.11	.70	.67	.09	.28	-.41	.37	.90	.10	.38	.43	-.74	.45	.10
5	44	.06	.33	-.29	-.04	.32	-.27	-.22	-.27	-.22	-.23	-.18	-.49	-.16	.09
6	46	.62	-.66	-.81	-.42	-.20	.31	-.73	-.02	-.18	-.56	-.61	-.31	-.67	.05
7	104	.51	.21	-.47	.22	.01	-.06	-.59	.21	.27	-.38	-.29	-.14	-.27	-.04
8	60	-.22	-.02	-.23	-.22	.11	.12	-.16	-.11	.19	-.25	-.15	.14	-.46	-.18
9	75	-.25	-.62	-.47	-.64	-.13	.19	.26	-.71	.09	-.20	-.20	.08	-.47	.50
10	32	-.19	-.39	-.15	-.41	.09	.13	.29	-.64	.20	.02	.01	.31	.02	.30
11	41	.25	.03	-.11	.02	-.07	.04	-.26	-.12	-.19	-.34	-.47	.21	-.06	-.31
12	141	.37	.00	-.18	.18	-.08	-.22	-.46	.27	.22	-.48	-.56	-.07	-.23	-.13
13	23	.39	-.54	-.67	-.64	-.09	.37	-.29	-.70	.20	-.61	-.53	.38	-.27	-.67
14	56	-.39	-.26	.02	-.43	-.14	-.17	.49	-.44	.61	.01	.55	-.26	.26	.24
15	29	.13	.09	-.33	.02	-.06	.05	-.02	-.20	.05	-.27	-.38	.45	-.09	-.13
16	24	-.73	.10	.08	-.60	-.24	.32	.83	-.76	.02	-.23	.16	.39	.18	.35

* Distance is the highway mileage from each township to either Oklahoma City or Tulsa (See Figure 3 for the delineation of the two Oklahoma metropolitan city regions in 1945).

** Numbers correspond with the variables listed in Table 2.

Table 6. Average Size of Farms by Type of Farming Area and Distance from either Oklahoma City and Tulsa.*

Type of Farming Area	Highway Mileage															
	Average	0-24	25-49	50-74	75-99	100-24	125-49	150-74	175-99	200-24	225-49	250-74	275-99	300-24	325-49	350-74
Total All Townships	311	159	215	208	248	276	302	516	441	614	492	1,175	1,027	1,325	2,126	3,254
1	1,214								674	582	767	1,175	1,027	1,325	2,126	3,254
2	742					381	507	876	688	1,528						
3	288	190	303	269	295	290	321	515								
4	598	329	552	786	911	349	204									
5	197	167	196	189	227	130										
6	455			338	313	390	545	723								
7	188	93	198	197	361											
8	174	367	187	143	153	210	174									
9	130	116	153	138	125	129	106	110								
10	105			118	98	97	110									
11	292					207	264	306	370							
12	249		228	204	235	310	310									
13	164	140	164	174												
14	161				156	208	157	138	173	89	81					
15	319				296	338	318									
16	147					224	171	154	145	115	80					

* Distance is the highway mileage from each township to either Oklahoma City or Tulsa (See Figure 3 for the delineation of the two Oklahoma metropolitan city regions in 1945).

City region includes part of those townships in type of farming areas 4, 7, 8, and 14, and all of those in areas 1, 2, 3, 6, 11, 12, 13, 15, and 16; the Tulsa region includes part of those in areas 4, 7, 8, and 14 as well as those in areas 5, 9, and 10.

Of the nine type of farming areas which are entirely within the Oklahoma City region, only in area 16 does farm size decline with increasing distance. Of the three type of farming areas completely in the Tulsa orbit, farm size declines with distance in two of them---areas 9 and 10 (Table 5). And, in four of the type of farming areas where the influence of Oklahoma City overlaps that of Tulsa (areas 5, 9, and 10), farm size declines with distance in three, but increases directly with distance in the fourth. Apparently, therefore, the average size of Oklahoma farms will vary somewhat regardless of either type of farming area or metropolitan city size. Since neither of the two factors exercises a preponderant influence on farm and population characteristics in the outlying countryside, the subsequent findings omit their consideration; each variable is analyzed solely in terms of distance.

Relationship Between Distance and Each Variable

When one considers all 967 townships in terms of their proximity to one of the two dominant Oklahoma cities, either Oklahoma City or Tulsa, ten of the fourteen variables correlate with distance. The correlation coefficients of only four variables, X_3, X_6, X_7, and X_{10}, are very small each being +.06 or less. Of the ten variables having coefficients of +.20 or higher, farm size (X_2) is the highest.

Farm Size. The coefficient of correlation between distance and the size of farms is .55 for the entire State (Table 7). Farm units become larger rather uniformly as one goes from the two major cities

Table 7. Coefficients of Correlation Between Distance and Each of the Fourteen Variables, with Averages of Each by Distance Intervals, Oklahoma.*

Highway Mileage	Number of Townships	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
		Variable Number **													
		Coefficients of Correlation													
All Townships	967	.55	-.02	.28	.28	.05	-.06	-.31	.23	-.05	-.54	-.41	-.20	-.38	.20
		Averages													
All Townships	967	311	41	3,346	2,479	102	33	2.0	57	7.0	2.0	41	87	72	-37
0-24	48	159	39	$7,120	2,103	101	32	3.7	51	6.8	3.4	65	93	99	-30
25-49	138	215	40	3,385	1,980	103	34	2.1	50	6.5	2.2	46	98	82	-41
50-74	191	208	41	3,368	1,985	103	33	2.2	52	6.8	2.3	47	98	84	-39
75-99	164	248	44	3,697	2,623	103	33	2.0	56	7.2	2.2	43	84	75	-38
100-24	153	276	41	3,382	2,642	101	32	1.8	58	7.3	1.9	38	83	65	-37
125-49	114	302	41	2,961	2,487	101	33	1.8	59	7.5	1.6	36	85	66	-37
150-74	77	516	36	2,184	2,675	101	33	1.4	64	6.8	1.3	29	83	60	-37
175-99	30	441	36	1,804	2,211	101	33	1.4	60	7.1	1.2	30	71	51	-35
200-24	13	614	30	1,590	2,533	102	34	2.5	49	9.8	1.2	50	95	74	-29
225-49	10	492	37	2,129	2,896	104	33	2.4	58	8.0	1.2	40	86	64	-32
250-74	10	1,175	46	2,374	7,480	110	31	.4	97	4.7	.4	10	19	18	-23
275-99	10	1,027	59	2,366	6,870	111	30	.4	98	3.0	.3	7	20	19	-9
300-24	4	1,325	57	1,729	5,867	107	33	.3	96	2.2	.2	5	20	16	-4
325-49	3	2,136	23	867	5,611	106	31	.2	90	2.7	.2	5	22	10	-1
350-74	2	3,254	10	498	4,216	102	30	.2	78	3.4	.2	4	26	7	-19

* Distance is the highway mileage from each township to either Oklahoma City or Tulsa (See Figure 3 for the delineation of the two Oklahoma metropolitan city regions in 1945).

** Numbers correspond with the variables listed in Table 2.

to the hinterlands, rising from about 160 acres within a twenty-five mile radius to about 300 acres at a distance of 125-150 miles, to about 1,000 acres at 250-300 miles away, and from 2,000 to 3,000 acres at 325 miles or more from the two metropolitan centers (Table 7). The striking jump in farm size at a distance of 250 miles and over, apparently, is attributable to the geographical location of these townships. All of them are in the Panhandle of the State where large farms and ranches are common (Figure 1).

Notwithstanding the relatively high degree of association between farm size and distance in the State as a whole, the Oklahoma City and Tulsa areas exhibit divergent patterns. Whereas the coefficient of correlation is .59 for the Oklahoma City area, it is a -.14 for the Tulsa area (Tables 8 and 9, respectively).

The negative correlation in the Tulsa region undoubtedly is the result of broken topography and diversified farming, for the size of farms drops sharply beyond 100 miles from that city (Table 9). In contrast, farm size in the western part of the State increases directly with distance from Oklahoma City since there is more uniformity in topography and in type of farming than in the Tulsa area of eastern Oklahoma (Table 8).

Density of the Farm Population. From the meager statistics on farm people published in the 1945 Census of Agriculture, this study analyzes four demographic factors: density, sex ratio, per cent of the total population under fourteen years of age, and the relative population changes during the 1940-50 intercensal decade. The first of the four items will be presented next. Since the spatial distribution of the farm population is partly a function of the average size of farms, an analysis of the density of farm residents immediately follows that

Table 8. Coefficients of Correlation Between Distance and Each of the Fourteen Variables with Averages of each by Distance Intervals, Oklahoma City region.*

Highway Mileage	Number of Townships	Variable Number ** X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
		Coefficient of Correlation													
Total Area	736	.59	-.06	-.36	.25	.03	-.01	-.36	.20	-.08	-.63	-.46	-.17	-.38	-32
		Averages													
Total Area	736	351	43	$3,566	$2,918	103	32	1.6	64	6.8	1.8	36	77	65	-37
0-24	29	137	42	$8,206	$2,450	102	31	3.8	60	6.7	3.3	63	83	92	-32
25-49	90	221	41	3,771	2,402	104	33	1.9	56	6.3	2.2	42	86	74	-40
50-74	126	214	45	3,717	2,369	103	32	1.9	58	6.6	2.3	42	89	77	-39
75-99	122	263	48	4,161	3,107	102	32	1.6	65	7.3	2.0	37	75	68	-39
100-24	122	306	44	3,750	3,133	101	31	1.4	68	7.3	1.7	33	70	57	-40
125-49	96	341	44	3,142	2,884	101	32	1.3	68	7.2	1.5	30	76	59	-38
150-74	71	551	37	2,259	2,874	103	32	1.2	68	6.6	1.2	26	78	57	-37
175-99	28	463	37	1,853	2,348	101	33	1.3	64	6.9	1.2	29	68	50	-36
200-24	13	614	30	1,590	2,533	102	34	2.5	49	9.8	1.2	50	95	74	-29
225-49	10	492	37	2,129	2,896	104	33	2.4	58	8.0	1.2	40	86	64	-32
250-74	10	1,175	46	2,374	7,480	110	31	.4	10	4.7	.4	10	19	18	-23
275-99	10	1,027	59	2,366	6,870	111	30	.4	98	3.0	.3	7	20	19	-9
300-24	4	1,325	57	1,729	5,867	107	33	.3	96	2.2	.2	5	20	16	-4
325-49	3	2,136	23	867	5,611	106	31	.2	90	2.7	.2	5	22	10	-1
350-74	2	3,254	10	498	4,216	102	30	.2	78	3.4	.2	4	26	7	-19

* Distance refers to the highway mileage of each township in the Oklahoma City region to Oklahoma City (See Figure 3 for the delineation of the two Oklahoma metropolitan city regions in 1945).

** Numbers correspond with the variables listed in Table 2.

of farm size. The last three items will be discussed at the end of this chapter.

The number of farm people per 100 acres of land in farms (X_8) varies inversely with distance from the two major Oklahoma cities, the coefficient of correlation being -.31 (Table 7). With but few exceptions farm population density shrinks with increasing distance, dropping from thirty-seven persons per 1,000 acres of farmland within twenty-five miles of the two cities to only two persons per 1,000 acres of farmland at a distance of 325 miles or more. The sudden drop in the density of the farm population beyond 250 miles is attributable to the fact that these townships are in the Panhandle of Oklahoma, an area of large-scale farms and ranches. This is consistent with a long standing principle of "negative correlation between the density of population and rurality and a positive relationship between density and urbanity." [2]

Although the Oklahoma City area conforms to Statewide configurations, the Tulsa area displays opposite tendencies (Tables 8 and 9). In the latter area the number of farm people per land area increase with distance from the city.

The proportional rise in the sparsity of the farm population with remoteness is largely a function of increasing size of farm units.[3] When

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[2]Pitirim Sorokin and Carle C. Zimmerman, Principles of Rural-Urban Sociology. (New York, 1929), pp. 20-23.

[3]The coefficient of correlation between X_2 and X_8 (farm size and density of farm population) is -.51. The two variables are highly related, irrespective of distance, for when one eliminates the influence of distance the partial correlation coefficient remains fairly high ($r_{2,8\cdot1} = -.43$). Moreover, farm size explains twenty-six percent of the variation in farm population density, whereas distance contributes less than one per cent of the explanation ($R^2_{8\cdot1,2} = .26$).

one eliminates the effect of farm size, the coefficient of correlation between distance and number of people per 100 acres of land in farms drops from -.31 almost to zero ($r_{1,8\cdot 2}$ = -.04).

Value of land and buildings. Investments in farm real estate per 100 acres of land in farms (X_4) vary inversely with distance for the State as a whole as well as in both the Oklahoma City and Tulsa areas, the coefficients of correlation being -.30, -.36, and -.38, respectively (Tables 7, 8, and 9). Moreover, the association between the two variables increases when one frees it from the effects of X_3, with the correlation coefficient rising from $r_{1,4}$ = -.30 to $r_{1,4\cdot 3}$ = -.37.

Obviously, the value of land and buildings per 100 acres (X_4) depends somewhat on X_3, the number of acres of cropland harvested per 100 acres of farmland ($r_{3,4}$ = .62), for cultivated land has a higher value than grazing land. In fact, the number of acres of cropland harvested explains thirty-eight per cent of the variation in the value of land and buildings per acre, whereas distance explains but nine per cent of its variation ($R^2_{4\cdot 1,3}$ = .47).

In contrast to the inverse relationship between investments in farm land and buildings per acre with distance, assets per capita correlate directly with distance in the entire State and in the Oklahoma City region. However, in the Tulsa region the value of land and buildings (X_5) varies inversely with distance (Table 7).

The value of land and buildings per capita is proportional to the number of acres in small grains per 100 acres of cropland harvested (X_8) and the number of acres of cropland harvested per 100 acres of farmland (X_3), the zero-order correlation coefficients being .75 and .56, respectively. Consequently, X_9 and X_3, respectively, explain fifty-six and thirty-one per cent of the variation in the value of Oklahoma farm land and buildings per capita ($R^2_{5\cdot1,9}$ = .57 and $R^2_{5\cdot1,3}$= .40). Thus, the correlations indicate that small grains require large acreages per farm and per farm worker, for the per capita value of farm property increases with distance, especially in the sparsely settled townships in the Northwestern part of the Oklahoma City area.

Spatial Distribution of Livestock. Dairying is an intensive farm enterprise which tends to concentrate near large consumption centers for immediate access to fluid milk markets to reduce marketing costs. Hence, it probably is one of the most valid indices of urban dominance over land utilization patterns. Conversely, range livestock is a rather extensive operation and is unable to compete with dairies and horticultural specialities for the occupancy of expensive land in close proximity to metropolitan cities. Therefore, cattle numbers (other than for dairy purposes) increase with distance from large municipalities, for this industry cannot outbid other uses on the high rental value of land.

(1) Number of Milk Cows. The number of cows milked in 1944 per 100 acres of land in farms (X_{11}) inversely correlates with distance, the simple coefficients being -.54 for the State, -.63 for the Oklahoma City region, and -.12 for the Tulsa region (Tables 7, 8, and 9). Accordingly, the number of milk cows decreases quite consistently with remoteness, dropping from thirty-four per 1,000 acres within a radius of twenty-five miles of the two Oklahoma metropolitan centers to only two per 1,000 acres at a distance of 300 miles and over.

The spatial location of the dairy industry is dependent upon a number of factors, two of which are distance and concentration of the farm population. The degree of association between cows and farm people is fairly high ($r_{8, 11} = .67$), because, first, dairying has high labor requirements; and second, about one-fourth of Oklahoma's dairy products were consumed at home in 1944.[4]

Distance, alone, explains twenty-nine per cent of the variation in number of cows milked per 100 acres of farmland ($r_{1, 11} = -.54$; $r^2_{1, 11} = .29$). Part of this is due to population density, for when one removes the influence of it the correlation coefficient between distance and milk cows drops only slightly--from $r_{1, 11} = -.54$ to $r_{1,11\cdot 8} = -.47$. Together, distance and farm population density explain fifty-seven per cent of the variation in number of cows milked per 100 acres of land in farms ($R^2_{11\cdot 8, 1} = .57$).

(2) Number of other cattle. In the Tulsa region of eastern Oklahoma, the number of cattle and calves, exclusive of milk cows, increases in direct proportion to distance ($r_{1, 10} = .25$). Moreover, the number of head climbs rather uniformly from seven per 100 acres of farmland within twenty-five miles of Tulsa to over nine between 125 and 200 miles away from that city (Table 9).

For the entire State, and the Oklahoma City area in particular, the number of cattle and calves, other than milk cows, increases proportionally with distance out to approximately 200 to 250 miles. Beyond this interval, nondairy animals are less than half as numerous as when closer in. Although this abrupt drop in cattle numbers is contrary to the relationships specified in the analytical models, one can readily

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[4]The estimated gross value of Oklhhoma dairy products--milk, cream, and butter--in 1944 was \$68,815,000. Of this amount, nearly twenty-six per cent, or \$17,662,000, went into home use.

Table 9. Coefficients of Correlation Between Distance and Each of the Fourteen Variables with Averages of Each by Distance Intervals, Tulsa Region.*

Highway Mileage	Number of Townships	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
		Variable Number**													
		Coefficients of Correlation													
Total Area	231	-.14	-.32	-.38	-.30	.01	.18	.26	-.48	.25	-.12	.07	.11	-.07	.16
		Averages													
Total Area	231	183	33	$2,643	$1,082	101	35	3.1	32	7.3	2.5	59	120	98	-35
0-24	19	194	35	$5,464	$1,573	100	33	3.6	37	7.0	3.4	68	109	108	-27
25-49	48	204	36	2,662	1,189	100	37	2.5	39	6.9	2.3	52	119	97	-42
50-74	65	197	35	2,691	1,241	101	34	2.7	40	7.1	2.4	57	114	98	-39
75-99	42	206	32	2,351	1,220	103	35	3.2	30	7.0	2.5	58	112	95	-33
100-24	31	150	27	1,905	645	100	38	3.6	20	7.4	2.5	61	137	97	-25
125-49	18	105	26	2,020	472	100	37	4.4	13	9.0	2.3	66	131	100	-28
150-74	6	105	23	1,293	323	100	37	4.1	12	9.2	2.3	65	146	98	-39
175-99	2	132	15	1,115	290	98	38	3.8	3	9.6	1.3	48	114	64	-32

* Distance refers to the highway mileage of each township in the Tulsa region to Tulsa (See Figure 3 for the delineation of the two Oklahoma metropolitan city regions in 1945).

** Numbers correspond with the variables listed in Table 2.

account for its occurrence. The averages for the townships in the 200 to 249 mile range are based upon cattle in both southeastern and northwestern Oklahoma townships. However, all townships 250 miles or farther out are in the Panhandle, where the large farms and ranches of this somewhat arid area have fewer animals per acre than the small farms of southeastern Oklahoma.

Cattle numbers respond to cyclical trends and vary from year to year. Other factors which influence the nondairy population and their geographic distribution at any particular date include the availability and supply of grain and pasture, livestock, capital, and the comparative prices of cattle and other farm commodities.

Crop Acreage. According to the formulations of the analytical models, economic rent decreases with distance from metropolitan centers. This presupposes a relative decline in cultivated crops, especially horticultural specialities, truck crops, and row crops having high labor requirements. Furthermore, it implies an increase in extensive crop acreage, pasture or grazing lands, along with enlarging farm units.

The number of acres of cropland harvested per 100 acres of land in farms decreases proportionately with remoteness from metropolitan cities. The Tulsa area, especially, conforms to the hypothesis of metropolitan dominance, having a correlation of -.32 (Table 7). Furthermore, harvested crop acreage diminishes rather rapidly with rising mileage (Table 9).

Whereas the relationship between distance and reaped crop acres is negative in the Oklahoma City area and in the State as a whole, the coefficients are very small (Table 7). Harvested acreage flucuates irregularly with distance, generally contaracting to about 200 to 250 miles, expanding in the 250 to 325 mile range, contracting again past that distance. Probably, the regional location of certain groups of townships partially explains the variation, for all townships in distance intervals 11-15, those 250 miles and over, are in the Panhandle of northwestern Oklahoma, where small grains are grown widely.

Since small grain production is much more highly concentrated in the northern and western parts than in the rest of the State, the Oklahoma City and Tulsa areas display contrasting ecological planting patterns. Accordingly, the coefficients of correlation between proximity and small grain acreage are .23 for the State, .20 for the Oklahoma City area, but a -.48 for the Tulsa area (Table 7). Only a negligible number of acres of small grains are planted in the outer-most reaches of the Tulsa region (Table 9). By comparison, over six times as many acres of small grains are grown within 125 to 200 miles of Oklahoma City (Table 8).

Many factors other than distance affect the relative dispersion and location of small grain production in Oklahoma: crop allotments, soil, weather, diseases, and insects perhaps are the principal ones identifiable by inspection. The value of land and buildings per capita varies directly with small grain acreage, accounting for fifty-six of the latter's variation ($r^2_{5,9} = .56$). And farm population density and distance, combined, explain fifty-nine per cent of the variation in the number of acres of small grains reaped per 100 acres of cropland harvested ($R^2_{9 \cdot 8, 1} = .59$).

__Productive Man Work Units__. The conceptual tools of this study posit a consistent diminution in metropolitan influence as distance to the rural hinterland increases. Correspondingly, this implies a steady decline in the intensity of all farm and ranch activities with growing inaccessibility. Reflecting the input of all labor in terms of ten-hour days, the total number of productive man work units (PMWU's) is a gauge of labor utilization in both crop and livestock production.

Table 7 reveals that total labor inputs per 100 acres of farmland are inverse to distance, the coefficients of correlation being -.38 for the State and the Oklahoma City area and -.07 for the Tulsa area. Farm manpower declines fairly regularly in the Oklahoma City area to about 200 miles, rises in the 200 to 250 mile zone, then drops sharply with increasing distance (Table 8). Even though total manpower requirements in the Tulsa surpass those in the Oklahoma City area for each distance interval, the decline in eastern Oklahoma is quite gradual from 25 miles out to a distance of 175 miles, then it drops sharply (Table 9). Obviously the contrasting differences in types of farming in the two metropolitan regions of the State--a rather uniform type in western Oklahoma, but a diversified type in eastern Oklahoma--contribute to the differential decline in the PMWU's with distance in the two separate areas.

In 1944 livestock production required nearly sixty per cent of Oklahoma's total farm labor, with forty-one of the seventy-two PMWU's per 100 acres of land in farms going into the care of animals and thirty-one PMWU's into crop production. Also, livestock PMWU's account for sixty-six per cent of the variation in total PMWU's per 100 acres of land in farms ($r^2_{12, 14} = .66$). Furthermore, livestock PMWU's decrease proportionately with distance in the entire State, the coefficient of correlation being -.41 (Table 7). Therefore, the overall labor utilized in the livestock industry drops sharply as distance mounts, falling from sixty-five PMWU's within twenty-five miles of the two major Oklahoma cities to ten of less per 100 acres at 250 miles or more.

Since the labor requirements of cattle kept for milk production are greater per animal unit than for other cattle, the decline in the total livestock PMWU's with distance is largely dependent upon the spatial distribution of dairy enterprises. In fact, dairying explains sixty-three per cent of the variations in livestock PMWU's per 100 acres of land in farms ($r^2_{11, 12} = .63$).

Also, the number of farm people is highly associated with livestock PMWU's the coefficient of correlation being $r_{8, 12} = .86$. Together, farm population density and distance account for seventy-six per cent of the variation in total livestock productive man work units ($R^2_{12 \cdot 1, 8} = .76$).

In the Oklahoma City area livestock PMWU's decrease proportionately with distance from that city ($r_{1, 12} = -.46$), whereas they increase slightly with distance in the Tulsa area ($r_{1, 12} = .07$). In addition, labor requirements in animal and milk production in the Tulsa area exceed those of the Oklahoma City area in every distance interval (Tables 8 and 9).

The number of crop PMWU's per 100 acres of land in farms decline rather consistently with distance in both the Oklahoma City and Tulsa areas, with the decline being greater in the former than in the latter area.[5] Nevertheless, labor requirements in crop production are somewhat higher in the Tulsa than in the Oklahoma City area.

Perhaps a more precise index of the intensity of cultivation is the total number of crop PMWU's per 100 acres of cropland harvested rather than the number of crop PMWU's per 100 acres of farmland. For

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[5] One obtains the number of crop PMWU's per 100 acres of land in farms by subtracting the livestock PMWU's from the total PMWU's per 100 acres of land in farms. Crop PMWU's per 100 acres of land in farms for Oklahoma City and Tulsa, respectively, by distance interval are as follows: distance interval 1, 29 and 40; interval 2, 32 and 45; interval 3, 35 and 41; interval 4, 31 and 37; interval 5, 24 and 36; interval 6, 29 and 34; interval 7; 31 and 33; interval 8, 21 and 16; interval 9, 24; interval 10, 24; interval 11, 8; interval 12, 12; interval 13, 11; interval 14, 5; interval 15, 3. (Note: Intervals 9 through 15 are only in the Oklahoma City area.)

the State as a whole and the Oklahoma City area crop PMWU's inversely relate to increasing mileage, the coefficients of correlation being -.20 and -.17, respectively (Table 7). However, crop PMWU's increase directly with distance in the Tulsa area ($r_{1, 13}$ = .11), for the crops planted there are more intensive than those grown in the Oklahoma City area, hence requiring larger labor inputs.

Since small grains entail the least labor of all crops, small grain acreage is highly inverse to crop PMWU's, the coefficient of correlation being -.86. On the other hand, labor requirements in livestock and crop production are rather closely interrelated, with the correlation between the two variables being .50.

Sex Ratio. A conspicuous characteristic of rural communities and frontier areas, particularly, is the disproportionate number of male inhabitants. Single females leave their parental homes at earlier ages and in larger numbers than farm males, thereby enlarging the farm sex ratio (number of males per 100 females). Theoretically, the masculinity of the farm propulation progressively rises as distance from metropolitan centers increases, for city attraction diminishes proportionately with declining proximity and farm emigrants tend to make only short moves.

In 1945 there were 102 males for every 100 females on Oklahoma farms, which is but a small preponderande (Table 7). Even though there is a positive association between sex ratio and increasing rurality, the coefficients of correlàtion are very small, being only .05, .03, and .01, respectively, for the State, the Oklahoma City area, and the Tulsa area (Tables 7, 8, and 9). In the entire State the sex ratio has its highest intercorrelation with average size of farms, for the sex ratio advances with expanding size of farm units (r_{26} = .21).

Proportion of the Population Under Fourteen Years of Age. Although the percentage of the total farm population under fourteen is not the most accurate measure of birth rates, it appropriately protrays fertility differentials. Also, it is a somewhat crude index of family size.

Throughout the nation birth rates are substantially higher in rural than in urban areas, with the highest rates occurring in the remote, isolated regions. According to the guiding concepts of this study, one expects to find pronounced gradients of city influence, with fertility increasing directly with distance from urban centers.

On January 1, 1945, one-third of Oklahoma's total farm population was youth less than fourteen years old. The spatial distribution in their proportionate numbers in the outlying countryside, however, does not vary uniformly with proximity to metropolitan centers. The correlation ratio is -.06 for the State, -.01 for the Oklahoma City area, and .18 for the Tulsa area, where the relative number of youths did expand directly with remoteness from the city of Tulsa (Tables 7, 8, and 9).

The smallest proportionate number of farm youths reside in the western Oklahoma counties 275 miles or more from Oklahoma City (Table 8). In contrast, the largest concentration of farm youths is in eastern Oklahoma, 100 miles or farther from Tulsa (Table 9). These marked differences indicate that the relative importance of income, education, and related factors upon fertility outweigh that of nearness. For example, there are negative correlations of -.54 between the percentage of farm youth and the value of land and buildings per capita (X_5) and between farm children and small grain acreage (X_9).

Changes in Farm Population During 1940-50. A widespread decline has occurred in the Oklahoma farm population; the loss during the 1940-50 period reached almost forty per cent, with about twenty townships out of the total of 967 recording increases. Presumably, the influence of the metropolitan centers upon the redistribution of the population in the outlying agricultural areas dwindles with distance. This suggests that the shrinkage in the farm population lessens with advancing distance from the city.

Generally, the disappearance in the farm population during 1940-50 becomes progressively smaller as one goes from the metropolitan centers to the extremities of the State. Moreover, the relative dedline lessens somewhat more rapidly with advancing distance in the Oklahoma City than in the Tulsa area (Figure 5).

Tables 7, 8, and 9 show that the proportionate decrease in the farm population is smaller within twenty-five miles of the two major Oklahoma cities than in the 25 to 100 mile range. This pronounced difference implies that farms in the immediate environs of the large cities have not consolidated as rapidly as farther out, owing to an increase in part-time farming, suburban residences, and commuting to work.

The townships 275 miles or more from Oklahoma City registered the smallest percentage population losses during the 1940-50 intercensal period. However, these Panhandle townships sustained huge losses during the 1930-40 dust bowl period, but the farm population has stabilized somewhat, since that time . In fact, several townships actually experienced gains in their farm populations during 1940-50.

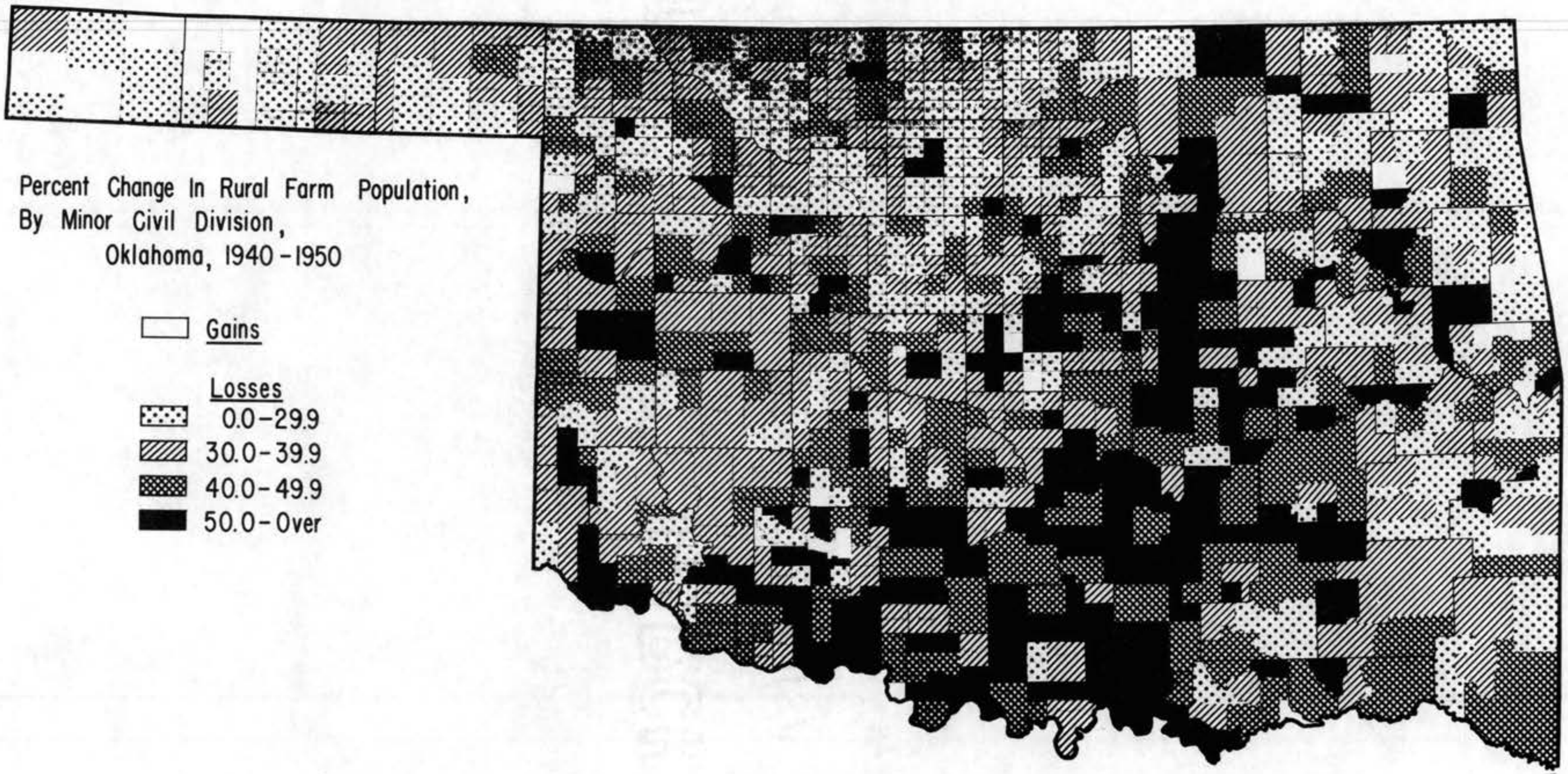

Figure 5. Percent change in Rural-Farm Population of Oklahoma Townships 1940-50

CHAPTER IV

Conclusion

Summary

This thesis postulated that the size of the urban center, the distance from it, and the variation in soil quality and physical resources were significant factors in producing differentials in agricultural land uses and in farm population composition. Correlation and arithmetic means were the statistical methods used in the final analysis. Statements in the findings as well as the conclusions set forth are results of the correlation and mean analysis. It tested the following three hypotheses: First, that ten selective farm and four farm population characteristics vary uniformly with distance to the two Oklahoma metropolitan centers; second, that these fourteen selective features of farms and farm populations vary uniformly with distance within each major type of farming area; and third, that these fourteen traits vary uniformly with distance within each city-size class.

Employing 1944 and 1945 agricultural and population data of the Oklahoma civil townships, the thesis presents the pertinent findings relative to each hypothesis in the preceding chapter.

The major findings and conclusions of the study are as follows: first, apparently the population size of the nearest dominant city has little relationship to the spatial distribution and characteristics of farms and farm people in the outlying townships. The fourteen rural-farm population and agricultural characteristics do not vary consistently with distance from each of the twelve major urban centers, for on each variable the coefficients of correlation are positive for the townships surrounding some cities and negative for those surrounding others. Furthermore, the fourteen characteristics do not vary consistently by city size within each of the fifteen mileage intervals, indicating that city (population of the dominant urban center) probably is an insignigicant factor in producing differentials in population composition and in farm utilization patterns in the outlying areas.

Second, although the type of farming area classification indicates a somewhat homogeneous grouping of townships by physical resources and soil types, farm land use patterns and the composition of the farm population do not vary consistently by distance within each area. In fact, the size of the coefficients of correlation of certain items with distance vary considerable among the sixteen types of farming areas; also, the coefficients for certain type of farming areas are negative and some positive on each and every characteristic. Type of farming areas 4, 10, 14 and 16 and 8 and 9, to a degree, deviate from the statewide configurations, indicating probable errors in farming area delineation, random fluctuations in the variables, or both.

Third, since farm and population characteristics do not vary uniformly with distance from major urban centers either within type of farming areas or by city size classes, the characteristics do not vary uniformly with distance when disregarding those two factors. Hence, the spatial distribution of certain characteristics conforms to the specifications of the analytical models; the ecological distribution of other features contradicts the models; whereas the distribution of others is apparently entirely random, providing no conclusive test of the hypotheses.

For the State as a whole, farming and ranching become more extensive as distance from the two Oklahoma metropolitan centers increases. For example, labor inputs decline proportionally with distance for both crop and livestock operations, hence total farm production per 100 acres of farmland. As distance from the two metropolises grows, farms enlarge in size, small grain acreage expands, milk cows dwindle in number, and farm population density falls. With increasing distance, the proportionate 1940-50 decline in the farm population lessens, the value of land and buildings per capita rises, but the value of land and buildings per 100 acres of land in farms declines.

Finally, proximity to the two Oklahoma metropolitan centers has a relatively minor influence upon the spatial location and concentration of four variables: sex ratio, per cent of the farm population under fourteen years of age, number of acres of cropland harvested per 100 acres of land in farms, and number of cattle and calves, exclusive of cows being milked, per 100 acres of land in farms.

Inferences

This investigation serves as the basis for further ecological, economic, and geographical studies. For instance, it uncovers vast differences in agricultural and farm population characteristics in eastern as compared to western Oklahoma. Also, it indicates contrasting patterns of dispersion within type of farming areas, within city-size groups, and by distance from cities. It remains for further studies to amplify the precise independent and interdependent effects of these variables upon agricultural land use patterns and population characteristics, and to determine which are linearly and nonlinearly distributed.

Subsequent studies should consider additional relevant variables including a more precise type of farming area classification which has become outdated in certain localities during the past twenty-five years.

Finally, further investigation should not preclude the possibility of devising an overall index of metropolitan or urban dominance, employing statistical techniques such as factorial or multiple discriminant analysis.

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APPENDIX A

ESTIMATED AVERAGE LABOR REQUIREMENTS FOR MAJOR CROPS AND LIVESTOCK CLASSES BY TYPE OF FARMING AREAS OF OKLAHOMA, 1957

CROPS, HOURS PER ACRE	AREAS								STATE
	1.2	3	4	5	6,11,12	7	8,9,10,14	13,15,16	WIDE
Wheat, harvested	1.8	2.2	3.5	3.5	2.4	3.5	3.5	3.5	
Oats	1.8	2.2	4.0	4.0	2.4	4.0	4.0	4.0	
Barley	1.8	2.2	3.8	3.8	2.4	3.8	3.8	3.8	
Rye	2.0	2.2	4.0	4.0	2.6	4.0	3.5	4.0	
Flax				3.6					3.6
Soybeans			6.7	6.7			6.7		6.7
Grain Sorghum	2.5	3.1	4.8	4.8	3.3	4.8	5.0	5.0	
Peanuts, Picked and Threshed			20.0	20.0	18.0	20.0	20.0	20.0	
Cotton			45.0	45.0	30.0	45.0	50.0	50.0	
Peanuts, Not Picked and Threshed			2.5	3.0	2.5	3.0	3.5	3.5	
Alfalfa	4.5	5.0	5.5	5.5	4.5	5.0	5.5	5.5	
Other Tame Hay	3.0	3.2	4.0	5.0	3.6	4.0	5.0	5.0	
Corn	8.0	8.0	9.0	9.0	9.0	9.0	9.0	9.0	
Irish Potatoes							60.0	60.0	
Sweet Potatoes					80.0		90.0	90.0	
Strawberries				200.0					200.0
Orchards, Vines, Nuts									100.0
LIVESTOCK, HOURS PER HEAD									
Horses and Mules	34.0	35.0	44.0	44.0	37.0	50.0	50.0	50.0	
Milk Cows	82.0	82.0	95.0	100.0	86.0	100.0	110.0	110.0	
Other Cattle	8.0	9.0	6.0	12.0	8.0	13.0	14.0	14.0	
Sows and Gilts	68.0	68.0	75.0	130.0	70.0	140.0	130.0	130.0	
Laying Hens (100)	120.0	120.0	120.0	120.0	130.0	130.0	140.0	160.0	
Turkeys Raised (100)	150.0	150.0	160.0	130.0	150.0	160.0	170.0	160.0	

APPENDIX B

Groupings of Crops and Livestock to be Used for Obtaining an Index of the Intensity of Oklahoma Agriculture, 1945.

Crops Harvested in 1944 (In Acres)

1. Total corn grown for all purposes

2. Small grains
   a. All sorghums grown except for sirup
   b. Oats threshed or combined
   c. Barley threshed or combined
   d. Rye threshed or combined
   e. Flax threshed or combined
   f. Wheat threshed or combined
   g. Soybeans grown alone except for green manure

3. Peanuts and cotton
   a. Peanuts picked or threshed
   b. Cotton harvested
   c. Peanuts, not picked or threshed

4. Alfalfa cut for hay

5. All other hay
   a. Clover or timothy cut for hay
   b. Lespedeza cut for hay

6. Irish potatoes, sweet potatoes, and strawberries
   a. Irish potatoes harvested for home use or for sale
   b. Sweet potatoes and yams harvested for home use or for sale
   c. Strawberries harvested

7. Orchards, vineyards, planted nut trees, and blackberries
   a. Land in fruit orchards, vineyards, and planted nut trees
   b. Blackberries harvested (tame only)

APPENDIX B (Continued)

Number of Livestock and Poultry on Hand January 1, 1945, Raised* or Milked** in 1944[1].

1. All mules, horses, and colts
   a. All mules and mule colts
   b. All horses and colts, including ponies

2. Total cattle
   a. Cattle and calves, other than milked cows
   **b. Cows milked in 1944

3. Sows and gilts for spring farrowing, on January 1,1945.

4. Chickens on hand over four months old, January 1, 1945.[2]

5. Turkeys raised in 1944.

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[1] United States Census of Agriculture, 1945, Oklahoma Counties and Minor Civil Difisions, Vols. I, II, and III.

[2] Only those chickens four months of age and over on farms were reported on January 1. Broilers under four months of age were excluded from this January 1 count. The number of chickens on January 1, therefore, is an approximation of the laying and breeding chickens on hand. United States Census of Agriculture, 1945, Vol. 1, part 25, Oklahoma, p. XIII.

APPENDIX C. Computations for the Hypothetical Example Illustrating Von Thunen's Principle.

Dis-	Milk		Watermelons		Wheat		Cattle Ranching	
tance (Miles)	Trans. cost	Econ. Rent*	Trans. cost	Econ. Rent*	Trans. cost	Econ. Rent*	Trans. cost	Econ. Rent*
2	$0.40	$9.60	$0.74	$9.26	$2.16	$7.84	$4.10	$5.90
4	0.80	9.20	0.98	9.02	2.32	7.68	4.20	5.80
6	1.20	8.80	1.22	8.78	2.48	7.52	4.30	5.70
8	1,60	8.40	1,46	8.54	2.64	7.36	4.40	5.60
10	2.00	8.00	1.70	8.30	2.80	7.20	4.50	5.50
12	2.40	7.60	1.94	8.06	2.96	7.04	4.60	5.40
14	2.80	7.20	2.18	7.82	3.12	6.88	4.70	5.30
16	3.20	6.80	2.42	7.58	3.28	6.72	4.80	5.20
18	3.60	6.40	2.66	7.34	3.44	6.56	4.90	5.10
20	4.00	6.00	2.90	7.10	3.60	6.40	5.00	5.00
22	4.40	5.60	3.14	6.86	3.76	6.24	5.10	4.90
24	4.80	5.20	3.38	6.62	3.96	6.08	5.20	4.80
26	5.20	4.80	3.62	6.38	4.08	5.92	5.30	4.70
28	5.60	4.40	3.86	6.14	4.24	5.76	5.40	4.60
30	6.00	4.00	4.10	5.90	4.40	5.60	5.50	4.50
32	6.40	3.60	4.34	5.66	4.56	5.44	5.60	4.40
34	6.80	3.20	4.58	5.42	4.72	5.28	5.70	4.30
36	7.20	2.80	4.82	5.18	4.88	5.12	5.80	4.20
38	7.60	2.40	5.06	4.94	5.04	4.96	5.90	4.10
40	8.00	2.00	5.30	4.70	5.20	4.80	6.00	4.00
42	8.40	1.60	5.54	4.46	5.36	4.64	6.10	3.90
44	8.80	1.20	5.78	4.22	5.52	4.48	6.20	3.80
46	9.20	0.80	6.02	3.98	5.68	4.32	6.30	3.70
48	9.60	0.40	6.26	3.74	5.84	4.16	6.40	3.60
50	10.00	0.00	6.50	3.50	6.00	4.00	6.50	3.50
52			6.74	3.26	6.16	3.84	6.60	3.40
54			6.98	3.02	6.32	3.68	6.70	3.30
56			7.22	2.78	6.48	3.52	6.80	3.20
58			7.46	2.54	6.64	3.36	6.90	3.10
60			7.70	2.30	6.80	3.20	7.00	3.00
62			7.94	3.26	6.16	3.04	7.10	2.90
64			8.18	1.82	7.12	2.88	7.20	2.80
66			8.42	1.58	7.28	2.72	7.30	2.70
68			8.66	1.34	7.44	2.56	7.40	2.60
70			8.90	1.10	7.60	2.40	7.50	2.50
72			9.14	0.86	7.76	2.24	7.60	2.40
74			9.38	0.62	7.92	2.08	7.70	2.30
76			9.62	0.38	8.08	1.92	7.80	2.20
78			9.86	0.14	8.24	1.76	7.90	2.10
80			10.10	-0.10	8.40	1.60	8.00	2.00

APPENDIX C. Continued:

Dis-tance (Miles)	Milk Trans. cost	Milk Econ. Rent*	Watermelons Trans. cost	Watermelons Econ. Rent*	Wheat Trans. cost	Wheat Econ. Rent*	Cattle Ranching Trans. cost	Cattle Ranching Econ. Rent*
82					8.56	1.44	8.10	1.90
84					8.72	1.28	8.20	1.80
86					8.88	1.12	8.30	1.70
88					9.04	0.96	8.40	1.60
90					9.20	0.80	8.50	1.50
92					9.36	0.64	8.60	1.40
94					9.52	0.48	8.70	1.30
96					9.68	0.32	8.80	1.20
98					9.84	0.16	8.90	1.10
100					10.00	0.00	9.00	1.00
102							9.10	0.90
104							9.20	0.80
106							9.30	0.70
108							9.40	0.60
110							9.50	0.50
112							9.60	0.40
114							9.70	0.30
116							9.80	0.20
118							9.90	0.10
120							10.00	0.00

*Economic rent at the market center is $10.00 per unit. Economic rent for each different distance intervals is derived by subtracting the transportation cost from the economic rent at the market center.

Milk - Based upon the assumption that transportation costs increase $0.20 per mile per unit, with no base cost. Each unit = 2,000 lbs.

Watermelon - Based upon the assumption that transportation costs increase $0.12 per mile per unit, with a base cost of $0.60 per unit for any distance of less than 2 miles. Each unit = 1,000 lbs.

Wheat - Based upon the assumption that transportation costs increase $0.08 per mile per unit, with a base root of $2.00 per unit for any distance less than 2 miles. Each unit = 2,000 bushels.

Cattle - Based upon the assumption that transportation costs increase $0.05 per mile per unit, with a base cost of $4.00 per unit for any distance of less than 2 miles. Each unit = 10,000 lbs. live weight.

APPENDIX D. Correlation Matrix for the Fifteen Variables.*

Variable Number**	Variable Number **														
	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
X_1		.55	-.02	-.30	.28	.05	-.06	-.31	.23	-.05	-.54	-.41	-.20	-.38	-.20
X_2			-.10	-.18	.54	.21	-.19	-.51	.44	-.15	-.54	-.56	-.40	-.56	-.13
X_3				.62	.56	-.06	-.37	-.20	.56	-.03	.06	-.22	-.39	-.01	-.17
X_4					.45	-.06	-.36	.21	.32	.12	.36	.12	-.27	.11	-.07
X_5						.13	-.54	-.55	.75	.00	-.38	-.58	-.65	-.57	-.20
X_6							-.02	-.19	.08	-.06	-.17	-.18	-.11	-.18	-.06
X_7								.38	-.54	-.07	.11	.33	.53	.41	.03
X_8									-.66	.15	.67	.86	.58	.78	-.00
X_9										-.04	-.28	-.63	-.86	-.69	-.21
X_{10}											.09	.31	-.07	.10	-.00
X_{11}												.79	.20	.62	-.02
X_{12}													.50	.81	.01
X_{13}														.77	.23
X_{14}															.09
X_{15}															

* Distance is the highway mileage from each township to either Oklahoma City or Tulsa (See Figure 3 for the delineation of the two Oklahoma metropolitan city regions in 1945).

** Numbers correspond with the variables listed in Table 2.

APPENDIX E. Averages for Eleven Specified Variables By Distance Intervals from Each of the Twelve Major Urban Centers*

City	City Average	0-24	25-49	50-74	75-99	100-24	125-49	150-74	175-99	200-24	225-49	250-74	275-99	300-24	325-49
Number of Acres of Cropland Harvested Per 100 Acres of Land in Farms (X3)															
Denver	33												16	32	46
Dallas	23				31	27	21	19	24	21					
Okla.City	43	43	41	42	44	42	46	37	46	38	45	52	73		
Tulsa	33	35	35	33	28	26	17								
Wichita, K.	68			70	64										
Amarillo	50					43	57								
Wich.Falls	51	55	48	62	41										
Ft. Smith	25	27	26	19	17										
Joplin	42	34	44												
Muskogee	41	46	35												
Enid	64	67	61												
Lawton	42	41	42												
Value of Land and Buildings Per 100 Acres of Land in Farms (X4)															
Denver	$1,170												757	1,138	1,438
Dallas	1,616				1,835	1,886	1,584	1,214	1,672	1,563					
Okla.City	3,523	8,206	3,771	3,450	3,598	3,133	3,299	2,160	2,114	1,746	2,215	2,760	4,195		
Tulsa	2,820	5,464	2,657	2,526	2,058	1,746	1,548								
Wichita,K.	6,532			7,067	5,613										
Amarillo	1,984					1,648	2,320								
Wich.Falls	4,022	3,417	3,554	5,748	4,281										
Ft. Smith	1,777	2,189	1,703	1,367	890										
Joplin	3,692	2,312	3,922												
Muskogee	2,764	3,339	2,149												
Enid	6,254	6,927	5,504												
Lawton	3,060	2,978	3,208												

Note: columns 0-24 through 325-49 are Highway Mileage intervals.

* Distance is the highway mileage from each township to the nearest dominant urban center (See Figure 4 for the twelve urban regions in Oklahoma).

APPENDIX E. Continued

~~Number of Acres of Cropland Harvested Per 100 Acres of Land in Farms (X_3)~~

City	City Average	Highway Mileage 0-24	25-49	50-74	75-99	100-24	125-49	150-74	175-99	200-24	225-49	250-74	275-99	300-24	325-49
Per Cent Rural-Farm Population Under 14 Years of Age (X_7)															
Denver	32												33	31	35
Dallas	36				34	36	35	36	38	37					
Okla.City	32	31	33	32	33	32	31	31	32	32	30	34	28		
Tulsa	34	33	36	33	35	36	35								
Wichita,K.	27			26	27										
Amarillo	30					30	30								
Wich.Falls	33	31	34	31	27										
Ft. Smith	38	38	38	38	34										
Joplin	32	35	32												
Muskogee	38	38	38												
Enid	28	28	28												
Lawton	31	32	31												
Number of Acres of Small Grains Harvested Per 100 Acres of Cropland Harvested (X_9)															
Denver	88												88	83	99
Dallas	19				19	22	24	16	10	11					
Okla.City	65	60	56	54	59	68	79	81	88	96	93	96	92		
Tulsa	38	37	39	42	31	28	25								
Wichita, K.	85			87	82										
Amarillo	99					98	99								
Wich.Falls	57	65	59	49	41										
Ft. Smith	12	10	13	13	17										
Joplin	46	41	47												
Muskogee	27	30	23												
Enid	90	92	89												
Lawton	70	70	69												

APPENDIX E. Continued

~~Number of Acres of Cropland Harvested Per 100 Acres of Land in Farms (X_3)~~

City	City Average	Highway Mileage 0-24	25-49	50-74	75-99	100-24	125-49	150-74	175-99	200-24	225-49	250-74	275-99	300-24	325-49
Value of Land and Buildings Per Capita (X_5)															
Denver	$5,542												6,545	5,106	5,912
Dallas	703				778	776	889	530	447	321					
Okla.City	2,728	2,450	2,402	2,097	2,650	2,552	3,312	3,335	3,201	5,078	4,576	5,892	9,584		
Tulsa	1,326	1,573	1,209	1,311	1,531	1,028	435								
Wichita,K.	5,311			5,679	4,679										
Amarillo	7,150					6,407	7,893								
Wich.Falls	3,323	2,602	3,179	4,056	3,128										
Ft. Smith	430	535	409	320	298										
Joplin	1,341	661	1,454												
Muskogee	738	918	546												
Enid	5,224	5,367	5,064												
Lawton	2,367	2,106	2,841												
Sex Ratio (X_6)															
Denver	102												103	100	106
Dallas	101				103	103	101	102	102	99					
Okla.City	103	102	104	103	103	103	100	103	99	107	108	109	95		
Tulsa	101	100	100	102	104	102	106								
Wichita,K.	100			98	102										
Amarillo	112					113	112								
Wich.Falls	103	95	104	104	99										
Ft.Smith	100	96	101	99	118										
Joplin	104	103	104												
Muskogee	100	98	101												
Enid	100	100	100												
Lawton	101	99	106												

APPENDIX E. Continued

~~Number of Acres of Cropland Harvested Per 100 Acres of Land in Farms (X_3)~~															
	City	Highway Mileage													
City	Average	0-24	25-49	50-74	75-99	100-24	-25-49	150-74	175-99	200-24	225-49	250-74	275-99	300-24	325-49
Number of Cattle and Calves, Other Than Cows Being Milked Per 100 Acres of Land in Farms (X_{10})															
Denver	2.7												3.0	2.8	2.2
Dallas	8.3				8.4	6.7	7.3	8.3	9.6	15.4					
Okla.City	6.6	6.7	6.3	6.5	7.3	6.7	6.9	6.5	6.0	5.7	5.7	4.6	4.8		
Tulsa	7.0	7.0	7.0	7.1	6.5	6.6	9.6								
Wichita,K.	7.4			7.4	7.4										
Amarillo	3.4					3.6	3.1								
Wich.Falls	7.6	7.1	7.7	6.6	10.8										
Ft. Smith	8.7	7.2	8.2	13.6	13.9										
Joplin	7.9	7.9	8.0												
Muskogee	7.2	7.3	7.2												
Enid	7.1	7.3	6.9												
Lawton	8.3	8.4	8.1												
Livestock PMWU's Per 100 Acres of Land in Farms (X_{12})															
Denver	5												4	5	4
Dallas	53				49	51	45	52	58	91					
Okla.City	36	63	42	43	39	32	27	21	18	12	14	11	9		
Tulsa	55	68	52	54	51	49	64								
Wichita,K	32			32	34										
Amarillo	7					7	7								
Wich.Falls	24	33	26	18	23										
Ft. Smith	66	58	66	83	63										
Joplin	66	85	63												
Muskogee	69	71	66												
Enid	31	34	28												
Lawton	30	34	23												

APPENDIX E. Continued

~~Number of Acres of Cropland Harvested Per 100 Acres of Land in Farms (X_3)~~

City	City Average	0-24	25-49	50-74	75-99	100-24	125-49	150-74	175-99	200-24	225-49	250-74	275-99	300-24	325-49
		Highway Mileage													
Crop PMWU's Per 100 Acres of Cropland Harvested (X_{13})															
Denver	22												19	223	22
Dallas	151				172	148	150	143	169	134					
Okla.City	76	83	86	95	87	72	54	54	38	20	19	19	19		
Tulsa	110	109	117	109	103	117	94								
Wichita,K.	28			25	32										
Amarillo	20					20	20								
Wich.Falls	111	71	107	122	170										
Ft. Smith	140	145	144	117	83										
Joplin	49	48	50												
Muskogee	152	139	166												
Enid	25	25	25												
Lawton	72	70	77												
Total PMWU's Per 100 Acres of Land in Farms (X_{14})															
Denver	11												7	11	14
Dallas	89				103	93	79	79	101	119					
Okla.City	65	92	74	79	72	59	51	43	38	20	23	21	23		
Tulsa	92	108	94	90	82	80	80								
Wichita,K.	51			49	54										
Amarillo	17					15	18								
Wich.Falls	76	72	71	90	92										
Ft. Smith	101	94	104	105	77										
Joplin	87	102	85												
Muskogee	131	136	125												
Enid	47	50	43												
Lawton	61	63	57												

APPENDIX C. Continued

~~Number of Acres of Cropland Harvested Per 100 Acres of Land in Farms (X_3)~~															
	City	Highway Mileage													
City	Average	0-24	25-49	50-74	75-99	100-24	125-49	150-75	175-99	200-24	225-49	250-74	275-99	300-24	325-49
Per Cent Change in Rural-Farm Populations, 1940-50 (X_{15})															
Denver	9												-23	-11	0
Dallas	44				-54	-44	-50	-34	-46	-29					
Okla.City	38	-32	-40	-41	-42	-41	-35	-37	-33	-33	-27	-28	-19		
Tulsa	36	-27	-42	-39	-31	-25	-20								
Wichita,K.	29			-26	-33										
Amarillo	9					-8	-11								
Wich.Falls	45	-56	-45	-41	-39										
Ft. Smith	28	-35	-24	-26	-20										
Joplin	27	-19	-28												
Muskogee	37	-37	-37												
Enid	31	-31	-31												
Lawton	42	-43	-40												

VITA

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Biographical:

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Education: Attended grade school in Gerty, Benedict, Holdenville, and Lone Oak, Oklahoma; graduated from Wetumka High School, Wetumka, Oklahoma, in 1955; received a Bachelor of Science degree from the Oklahoma State University, with a major in Rural Sociology, in August, 1959; completed requirements for the Master of Science degree in May, 1961.