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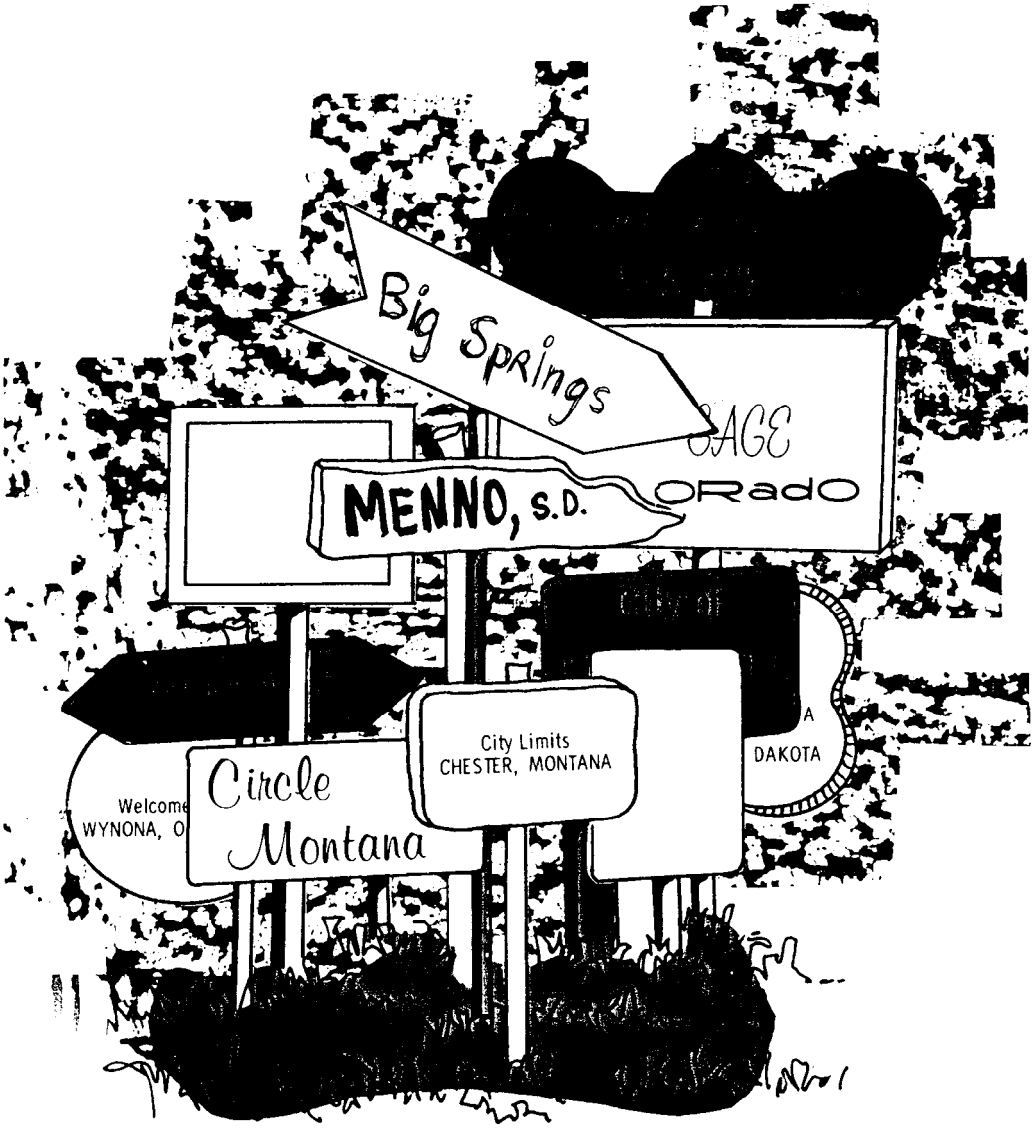
CHANGES in a South Central Kansas Trade Area 1937-1960



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CONTENTS

Changes in a South-central Kansas Trade Area[1] 1937-1960

by R. D. McKinney and Sandra Dawe[2]

A study of the Little River, Kansas, trade area for selected commodities and services was completed in 1938.[3] Then and now Little River's economic activity was and is based on agriculture, typical of the business activity of hundreds of small towns in the Great Plains.

Small towns have experienced the changes associated with increases in farm size, decline in rural population, increased per capita income and the necessity to increase retail volume to maintain competitive position. Associated with the changes are ease and speed of movement that let rural people depend less on small trade centers with fewer goods and services. The economy of the small towns in the Great Plains generally is based on agriculture and is influenced by rural changes as well as changes in retailing. Little River, Kansas, is typical.

The changing status of the small "country town" was noted in the 1938 study. Among the changes 20 years preceding 1937 were the passing from Little River of the harness shop, livery barn, cabinet shop, tin shop, bakery, men's clothing store, radio shop, automobile agency, ice and storage plant, and the general merchandise store.[4]

The town, its area, and its economy in 1937 were thus described:

> Little River, with its 664 inhabitants, lies in eastern Rice County, in the center of Kansas, and also in the center of the hard (red) winter wheat belt. The county is predominantly agricultural, the only other businesses of major importance being oil development, salt mining, and flour milling. Along the branch line of the Atchison, Topeka and Santa Fe Railroad, which passes through Little River, small towns or stations are located at intervals of from six to eight miles. . . . When wheat was hauled to the nearest loading point by team and wagon, groceries, dry goods, and the few services needed were naturally secured at the same place, and thus a small trading point grew. However, with better roads and improved transportation facilities these cross-roads stores have lost much importance. . . . Such is the trend . . . , the elimination of the smallest trading points.[5]

In 1960, Little River's population was 552. From 1940 to 1960, grain sorghum acreage quadrupled, and became more than double the corn and wheat acres lost from 1940 to 1960.

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2. R. D. McKinney, Assistant Professor, and Sandra Dawe, former research assistant, Department of Economics, Kansas State University.

3. Paul Clutter Perry, Master's Thesis, unpublished. **The Trade and Service Territory of Little River, Kansas, and Factors Influencing Its Extent** Manhattan, Kansas: Kansas State College of Agriculture and Applied Science, 1938.

4. **Ibid.,** p. 1.

5. **Ibid.,** p. 3.

The county is still predominantly agriculture, and oil and salt production still has economic importance.

Little River is the only town over 175 population in the 30 miles between McPherson and Lyons. The community is served by a U. S. east-west highway, and the Atchison, Topeka and Santa Fe Railway maintains freight service on a branch line.

The following background from the 1937 study set the stage for the present study.

> After all, this study (1938) does not show a trend, but only gives something of the general feeling of those who have been in business long enough to note the trend. In talking with these men one will gather that business has decreased in the past 16 years because of a small decrease in rural population, the progressive decrease (fancied or real) in the value of the farmer's dollar, power farming, which has done away with large harvest and threshing crews, and automobiles and good roads, which have taken the trade to larger towns.[6]
>
> Clark says, 'Crossroads stores, village stores, and small-town stores have lost trade to stores located in county seats and other cities from 6,000 to 25,000 population. . . . These changes have been taking place for a number of years, but have been particularly rapid since 1920.
>
> On the whole the stores that have suffered most from this shift in consumers' buying habits are those in the towns of fewer than 1,500 population, and particularly the very small villages with 500 or fewer persons. . . .'[7]
>
> From another recent book (1936) on marketing comes this quotation: 'The automobile and paved roads have very greatly extended the trading areas of the larger cities. There were literally thousands of thriving little towns in the early part of this century, but now a great many . . . have been reduced to a school, a few gas stations, and stores selling other merchandise . . . used by the traveling public. Cities large enough to maintain good hotels, theaters, and well-stocked stores have gained. . . . In other words, their trading areas have been extended to cover the territory formerly supplied by the small stores in small towns, villages, and hamlets.'[8]

"These quotations seem pessimistic to the small town resident, and yet they are the same facts which Little River merchants have noted. Their validity cannot be denied. They must be faced if those in small towns are to protect their investments."[9]

Purpose and Scope of Study

The above was observed and reported before 1938. Today, 1965, the impact of change and new technology continues. The sphere of influence of the small towns changed considerably before 1920 and continued through 1937. This study examines changes in and around the representative small town since 1937.

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6. **Ibid.,** p. 3.

7. Clark, Fred E., **Principles of Marketing.** New York, Macmillan, 1932, pp. 290-293.

8. Agnew, Hugh E., Robert B. Jenkins, and James C. Drury, **Outlines of Marketing,** New York and London, McGraw-Hill Book Company, Inc., 1936, p. 257.

9. Perry, **op. cit.,** p. 65.

Perry observed, "The present trends, of course, can only be estimated from what has occurred in the past, and the future of this country town can be accurately forecast only by studies similar to this made at well-chosen intervals in the future."[10] This report compares trade area data collected in 1937 with data collected by the Area Development Project in a trade area survey in south-central Kansas in 1960. The two studies let us document the change that has occurred in one town that is typical of hundreds. Present-day business standards (resources needed to support businesses) also are compared to those available in the Little River area, and projections from past and present trends are made.

Are the two studies comparable? In both, the residences of the customers were plotted on maps of the areas. There is, however, a basic difference in methods of collecting data. The 1960 survey consisted of contacting (by mail) 100% of the rural families in south-central Kansas and asking them to return a post card indicating where they purchased the majority of certain items (e.g., food, clothing, feed) and where they obtained certain services (e.g., banking services, physicians' services). Instead of taking a sample of the area, Perry contacted people known to be Little River customers. He interviewed the customers of a particular business as they came to trade on two or more principal shopping days and obtained: (1) location of their residence; (2) town that received over half of their trade (for a particular item); (3) reason they traded in that town; and (4) whether the percentage of their trade in that town was increasing or decreasing or was about the same as it had been for a number of years. Regarding this last point, Perry said:

> **The most difficult question from the standpoint of positive and reliable answers. . . . The trouble was encountered when this was put to those country folks who had lived in the vicinity for a number of years. Their first answer was almost invariably, "about the same as always." However, if the question was pressed, practically every one of them recognized . . . that . . . they made more trips to more distant towns for various reasons, and that they often bought . . . supplies of food in those towns. . . . The conclusion was that the value of the answers to this question was doubtful, and that probably there were more purchases of food outside of Little River than was apparent at first.**[11]

Procedure

Perry varied the procedure slightly for different commodities. In collecting data on food stores (there were two) he used the above procedure and then checked the list with store managers, who added names of a few customers. Then Perry interviewed the additional customers. He reported: "A special effort was made to talk to . . . customers on the outskirts of

10. Perry, **op. cit.,** p. 2.
11. Perry, **op. cit.,** pp. 17-18.

the area to determine more closely the breaking points."[12] To determine the banking trade area, a list of customers was obtained from a bank employee. Their residences were plotted, but none was interviewed. For the feed trade area, lists of customers were obtained from the two produce stores, and the customers were interviewed.

The location of each customer was plotted on a map, with a distinction made between those who bought more than 50% of an item in Little River and those who bought less than 50%. After plotting maps for each commodity, Perry combined all maps to show the location of each customer and how many commodities he purchased in Little River. A single trade area then was outlined. Perry had set up no criterion to delineate the trade area, except straight lines to include areas densely populated by Little River customers and to exclude areas where customers began to "thin out."

His trade area boundaries were points from which half of the individuals go one way to trade and half go the other. However, the number of persons he interviewed appears sufficiently large to be an adequate sample. According to our rough calculations based on the populations of the townships in which his observations lay and the average number of persons per rural household, Perry's samples included approximately: for food stores, 37.2%; for the bank, 20.9%; and for produce stores (feed), 27.8%.

In the 1960 study, all rural families were contacted; 26% responded to mailed questionnaires. Using a code for each town where purchases were made and a separate map for each commodity, residences of respondents were plotted. Then using a hexagon-pattern overlay, it was determined how many respondents residing in a particu1ar hexagonal area purchased a particular item in each town.[13] When more than 50% of the respondents in a hexagon purchased an item in one particular town, e.g., Little River, that hexagon was included in the trade area. A series of hexagons, then, makes up the geographical area called the trade area. Trade areas sometimes overlap, and the area of overlap is referred to as a trade-area complex. Overlap occurs when responses are split 50-50, or three ways, among different towns. Such a hexagon is considered to lie in two or three trade areas.

We also applied the hexagon-pattern method to Perry's commodity maps, so we could compare the two sets of data. Perry had plotted his observations in the same manner as used in the hexagon-pattern method. Only one half of the hexagon area was counted as being in the Little River trade area when residences of Little River customers were sparse at the margins, while half was counted in another trade area, making a trade-area complex. Hexagons were included where: (1)

12. Perry, **op. cit.,** p. 16.
13. This method of determining market areas is explained in Appendix A.

Table 1

Businesses operating In Little River, Kansas, in 1937[1]

Businesses	Number
Grocery store and meat market	2
Mercantile store (men's, ladies', and children's ready-to-wear)	1
Filling station	4
Tire and battery shop (also auto and tractor repairs and repairing)	1
Garage (auto and tractor repair, farm machinery dealer)	1
Furniture store (furniture and undertaking)	1
Hardware and lumber yard	1
Hardware, farm machinery, coal	1
Coal yard	1
Ice and coal retailer	1
Restaurant	3
Beer parlor and lunch	1
Bank	1
Grain elevator	1
Produce and feed store	2
Dry cleaner shop	1
Blacksmithing and welding shop	1
Theatre	1
Shoe repair shop	1
Photo shop (school supplies and novelties)	1
Pool room	1
Barber shop (beauty shoppe)	2
Practicing physician	3
Dentist	1
Hotel	1
Hospital	1
Gas company office	1
Library	1
Weekly newspaper	1
Total number of businesses	40

Businesses operating in Lltttle River, Kansas, In 1957[2] and 1964[3]

Businesses	Number 1957	Number 1964
Gas stations	4	3
Stores (general, department)	1	1
Wholesalers	1	2
Repair services	1	0
Machinery (except electrical)	1	0
Building materials & construction equipment (incl. hardware)	2	1
Grain and warehousing	1	0
Food (groceries, markets, bakeries)	3	1
Construction-building	1	2
Retail stores, feed, supplies (miscellaneous)	2	1
Garages, auto repair	1	0
Printing, publishing	1	1
Little River Telephone Company	1	1
Amusement (except movies)	1	0
Construction	2	1
Furniture (furnishings, etc.)	2	1
Physician[4]	1	1
Hospital	1	1
Hotel	1	1
Library	1	1
Bank	1	1
Grain elevator	1	1
Barber shop	1	1
Cleaning & dyeing plant	1	1
	33	23

1. Perry, op. cit., p. 15.
2. Dun & Bradstreet Inc., Reference Book, March 1957, New York: Dun & Bradstreet, 1957, p. 1181.
3. Dun & Bradstreet Inc., Reference Book, September 1964, New York: Dun & Bradstreet, 1964.
4. This and the following items obtained from personal knowledge of an Area Development employee.

several persons who bought "some" but not "most" of an item in Little River, and (2) several persons who bought "most" items were on the innermost part of the hexagon that contained several others who bought "some" items at Little River.

This report is concerned only with commodities for which data were available for both 1937 and 1960. Advances in technology have brought changes in kinds of goods and services needed and desired. For example, advances in heating and refrigeration put coal and ice dealers out of business. Table 1 shows the change in types, as well as the number, of goods and services offered in Little River. In 1937 Little River had a clothing store but no one Perry interviewed said he bought "most" of his clothing there. The store's stock was limited, and purchases were made there mostly for convenience; people went elsewhere for major items. In 1960 Little River did not have a clothing store. Clothing is only one example of items demanded and offered for sale but not supplied

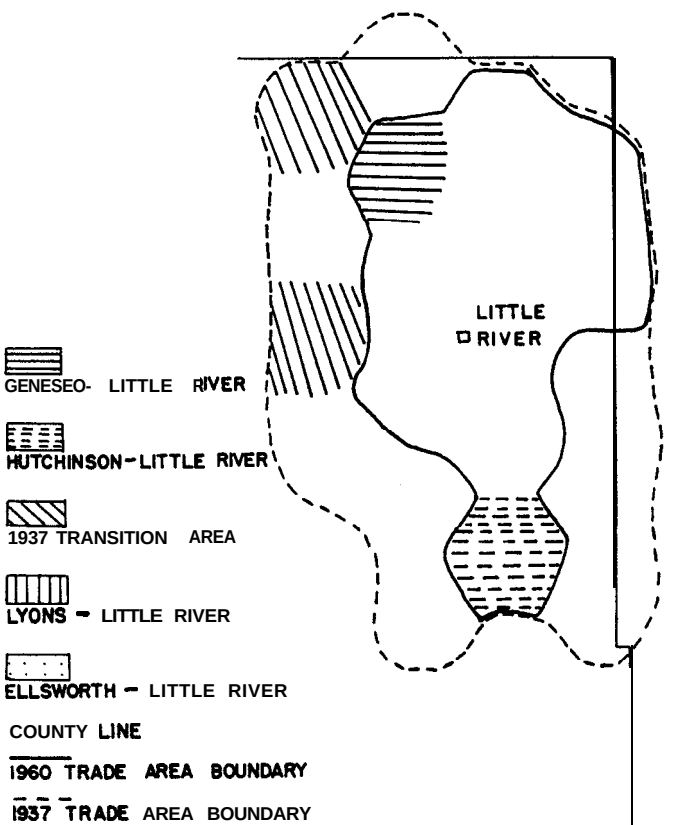


Fig. l.-Little River Food Trade Area, 1937-1960.

by small towns, largely because a small-town storekeeper cannot afford to stock the variety of goods demanded today.

Commodity Trade Areas

Figures 1, 2, and 3 show outlines of trade areas for different commodities and services for both 1937 and 1960. Patterned hexagons indicate that the areas fall in the Little River and other town trade areas. Such areas might be called "transitional"; i.e., at one time half the people are going to Little River and half to another town, and a shift to one or the other is expected. This assumption is supported by the maps: the "transitional" areas of 1937 are no longer in the 1960 trade area.

The maps show considerable contraction of trade areas during the 23 years between the two studies. The maps show

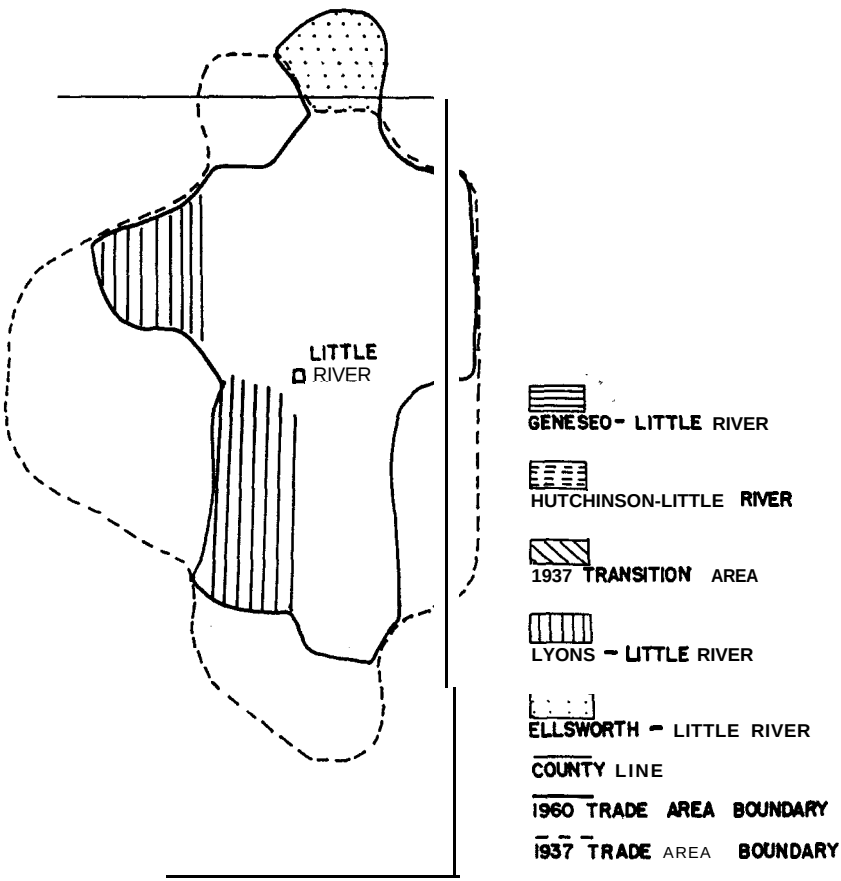


Fig. 2.—Little River Banking Trade Area, 1937-1960.

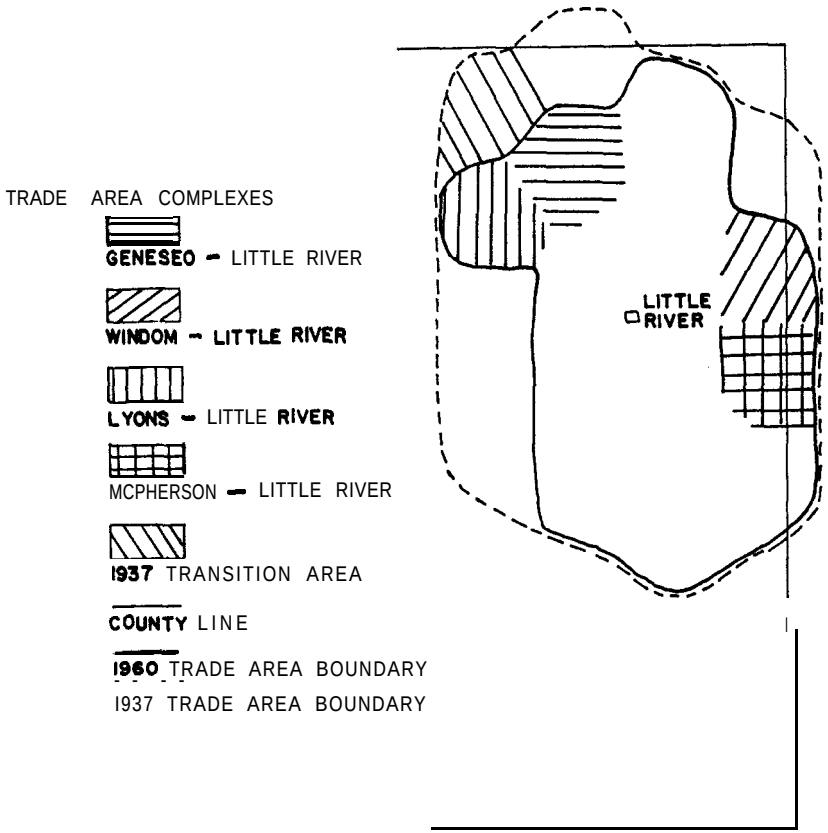


Fig. 3.--Little River Feed Trade Area, 1937-1960.

both the extent of decrease and the directions from which business has declined. Figure 1 shows that Little River has lost food trade area in all directions except northeast. Only small towns, not over 700 population, are found for 30 miles northeast. The bank also has retained its 1937 northeast trade-area boundary. It has lost less area in other directions than grocery stores have. The banking trade area is unique for extending its boundary north. The feed trade area (Figure 3) has been contracted from east, west, and northwest.

Table 2.-Changes in size of Little River trade area in square miles.

	1937	1960	Numerical decrease	% decrease
Food trade area	**256.50**	**128.25**	**128.25**	**60.00**
Banking trade area	**283.50**	**148.50**	**135.00**	**47.62**
Feed trade area	**236.25**	**148.50**	**87.75**	**37.14**

Table 3.--Changes in population of Little River trade areas.

	1937	1960	Numerical decrease	% decrease
Food trade area	2816[1]	1182[1]	1634	58.03
Banking trade area	3068	1275	1793	68.44
Feed trade area	1974	792	1182	69.88

1. Based on a trade area size of 256.50 square miles in 1937 and 128.25 square miles in 1960. Only a portion of the population (in proportion to the trade originating from the hexagon) was included for areas identified as trade area complexes. In all instances each township's population density for each year was used to aggregate the trade area population. The same procedure was used for banking. Calculations for feed differed only by the assumption that people in Little River bought no significant amount of feed, therefore the town population was excluded.

Table 2 gives the size (in square miles) of various trade areas for 1937 and 1960 and numerical and percentage decreases. The area was calculated by multiplying the number of hexagons in a trade area by the size of the hexagon, 13.6 square miles. "Transitional" areas were calculated as half of a hexagon each.

Population Density and Trends

The population of each hexagon was determined by multiplying 13.5 square miles (the size of the hexagon) by the population density of the township in which the hexagon fell. Total population of all whole hexagons in the Little River trade area plus half the population in each "transitional" hexagon equals the trade-area population. The figures for each trade area for both years and the numerical and percentage changes are given in Table 3. Under the assumption that all Little

Table 4.-Rural population of townships that constitute Little River trade areas and population of Little River.

	1910[1] population	1937[2] population	% change '10-'37	1960[3] population	% change '37-'60
Galt	412	262	– 36.41	162	– 38.17
Odessa	.....	222	.....	100	– 54.95
Mitchell	503	336	– 33.20	225	– 33.04
Union	907	364	– 59.87	220	– 39.56
Rockville	409	270	– 33.99	219	– 18.89
Wilson	544	371	– 31.80	203	– 45.28
Total rural	2776	1825	– 34.23	1129	– 38.14
Little River	661	664	+ 0.45	552	– 16.87
Total. including Little River-	3436	2489	– 27.56	1681	– 32.46

1. U. S. Bureau of the Census, **Thirteenth Census of the U. S., 1910,** Vol. II. Washington, D. C.: U.S. Government Printing Office, 1911, p. 660.

2. Kansas State Board of Agriculture, **Thirty-first Biennial Report, 1937-38,** Topeka, Kansas, Kansas State Board of Agriculture, 1938, p. 356.

3. U. S. Bureau of the Census, **U. S. Census of Population 1960. Number of Inhabitants Kansas,** Washington, D. C.: U. S. Government Printing Office, 1961, 22.

River residents do the majority of their banking and grocery shopping in Little River, the Little River population is included in the total trade-area population. Likewise, it is assumed that Little River townspeople do not buy feed; therefore the Little River population is not included.

Table 4 shows the decrease in population in the six townships, parts of which make up all of the 1937 trade areas and most of the trade areas for 1960. Comparing Table 3 and Table 4 shows trade-area population has decreased faster than actual population, indicating that persons still living in the 1937 Little River trade area now do substantial trading in other centers. See decrease in the size of trade areas, Figures 1, 2, and 3.

While the total rural population of the townships decreased 38.14%, feed trade area population decreased 59.88%, and food and banking trade area populations decreased 58.03% and 58.44% respectively. The total population of the six townships, including Little River city, decreased only 32.46%.

U. S. Census data and Dun and Bradstreet data, in addition to the trade-area data presented, indicate a continuing decline in business done by Little River merchants. Most basic indicator is declining population. Perry discussed population as a determinant of trade and found that rural population of Rice county (the six townships of the Little River trade area in 1937) had declined over one third between 1910 and 1937 (27 years). In the 23 years between Perry's study and the 1960 trade area survey, rural population of the same townships again declined more than a third (Table 4). Figure 4 shows those declines graphically for each township. If this trend continues, as seems likely, the total population in the trade area will become too small to support local businesses. The rate of change in the trade area population (Table 3) makes the outlook even more pessimistic.

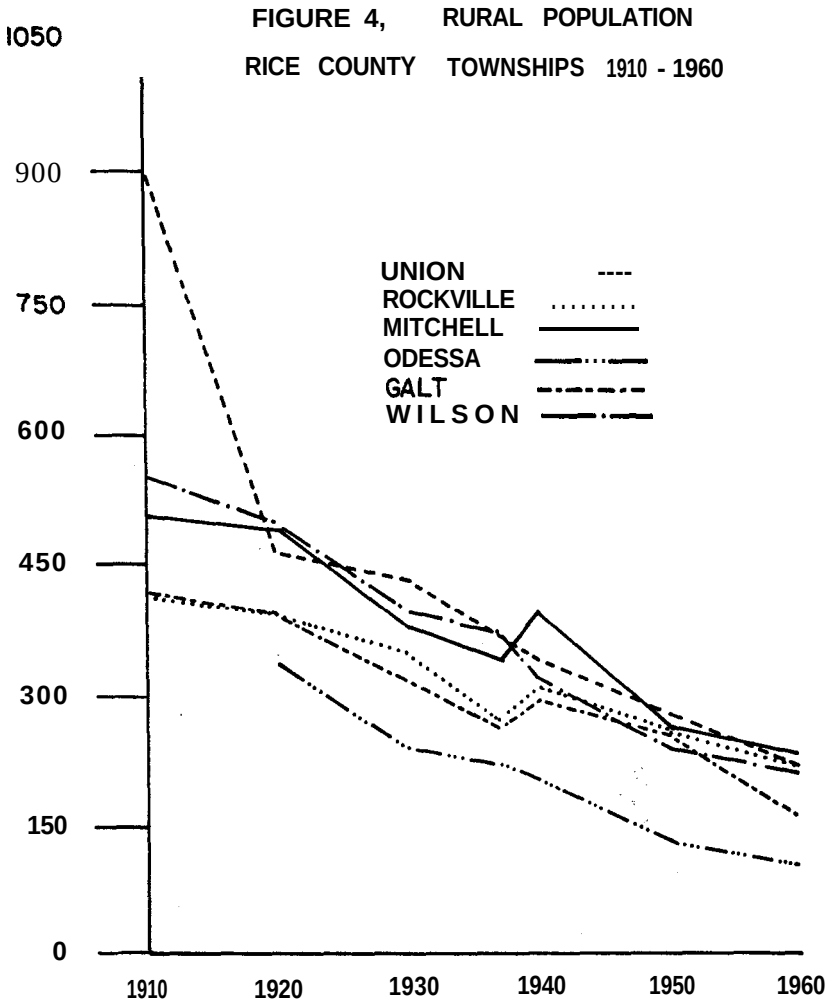
Customers Needed to Support a Food Store

Recent research data[14] indicates that a retail food store needs 400 customer families to insure business enough to provide a respectable level of living. Average size of store necessary to insure adequate product selection and inventories is 6,000 square feet, though this is somewhat smaller than the typical city grocery store of the World War II era.[15]

The total rural population of the five townships in the 1960 Little River food trade area was 926. The Little River population (552) gives 1,478. The 3.1 persons per occupied rural

14. John W. Knox, **Survey of Trade Areas in West-central Kansas, Area 4,** Manhattan, Kansas: Extension Service, Kansas State University, MF125, 1963, p. 13.

15. The above study specified that the average number of employees necessary to adequately service the store is 8, and that gross retail sales necessary to provide a reasonable level of living for the owner = $300,000. "The preceding rule-of-thumb will return a net income of $7,000 to $12,000, depending on individual management capabilities."



housing unit (rural household) (1960 Census) gives 477 households and potential customer families.

Table 3 indicates that the Little River food trade area population in 1960 was only 1,182 or 381 customer families. One of three grocery stores (Table 1) in Little River in 1957 remains in 1964. The present trade area population is not adequate to support a grocery store of the above standards. The continued gradual decline in population continues to reduce businesses of small towns so they cannot provide desired goods and services, and thereby force customers to larger towns.

The reduced number of businesses in Little River is another indicator of the decline of business. Perry listed 40 businesses

in Little River in 1937, but named 10 that left Little River during the 20 years before 1937. Table 1 shows businesses listed for 1937, 1957 and 1964, and the total number for each year.

Table 5 shows the change in the number of businesses between 1917 and 1964. Note that decline was 20% between 1917 and 1937 compared with 30% between 1957 and 1964.

Figures in Table 5 confirm trade area study results. Both show that with improved transportation people travel farther to obtain larger selections of items than available in Little River. Over time the trend continues and people become more accustomed to having and expecting large selections of commodities available for purchase. New types of businesses (nonretail) that have come into Little River since 1937, e.g., the wholesalers and the construction-building firms, might be exceptions.

Businessmen's View of the Future and Potentials

In a related study, 71 south-central Kansas businessmen were interviewed regarding their volume of business and what they thought the future held for business in the area and their own businesses in particular.[16] Four of those businesses were located in Little River. One question asked the businessmen to outline their trade areas.[17] Their outlines showed larger areas than those shown for their particular commodity trade areas in the post card survey, some as much as 108 square miles larger. The businessmen apparently included scattered customers who live outside the trade area found by the post card survey.

All but one businessman said they were trying to expand their trade areas (or volume of business) and hoped to expand two or three miles east, north and south.

On future economic prospects for their city and their business, only one businessman felt that both "will grow"; another said the city would decline, but his business would grow; a third said the city would decline, but his business would remain the same; the fourth thought both would decline. Except for one, their expectations run counter to trends established by data presented.

Businessmen of south-central Kansas in 1960 said low and variable farm income, plus diminishing number of farms, was the most serious problem facing business in increasing volume of trade with farmers. Number of farms and households has decreased over time, so the number of customers left in the Little River trade area is too few to provide the necessary base for expansion of usual retail outlets.

The problem of low and variable farm income seems to be most unique to the small business and the small towns. In a

16. R. D. McKinney et al., **South Central Kansas Survey Highlights,** Manhattan, Kansas: Extension Service, Kansas State University, MF101, May 1962, pp. 25-27.

17. See Appendix C.

Table 5.--Number of, and percentage decline of businesses in Little River for indicated periods.

Year	1917	1937	1957	1964
Number	50	40	33	23
Years	1917-1937 (20 years)	1937-1957 (20 years)	1967-1964 (7 years)	
% Decline	20	17.5	30.3	

companion study (1960)[18] in south-central Kansas, the buying habits of operators of large farms were studied.[19]

Farmers with an average net income of $6,000 (1960) were bypassing businessmen who listed "low incomes" as their primary problem in expanding trade with farmers. As farmer incomes increased so did their traveling to the larger trade centers for product selection, services and competitive prices.

Summary and Conclusions

Hundreds of small towns in the Great Plains have evolved through some drastic changes since 1937, as has Little River, Kansas. This study could have been of any of hundreds of towns.

Changes from 1937 to 1960 or 1964 were drastic though not noticeable year by year. However, change is usually continuous over time. The changes that affect a small town this year and this decade depend on many conditions, among them: continued population decline, continued technological changes (for example, refrigerators and disappearance of the iceplant), the business climate of the community and the economic viability (ability to change and grow with the times) of the trade center.

Tables 1 to 3 show the decrease in Little River business. Its businesses declined by a third in seven years, its trade area declined 37 to 50% since 1937, and its trade area population declined by almost 60%.

Projecting (starting with 1920) population of townships now in or partially in the Little River trade area indicates a population of about 800 by 1970 compared with 1,129 in 1960. Projections can be made in several ways and the set of data used can be varied, so estimates of population for any unit may vary widely.

Trends that have persisted in the Little River trade area since 1920 indicate that the townships' population will be substantially less than 1,129 by 1970. If the trade area continues to shrink, as in the past, the number of customers or house-

18. R. D. McKinney, *op. cit.*, p. 27.

19. R.D. McKinney et al., **Northwest Kansas Survey Highlights,** Manhattan, Kansas: Extension Service, Kansas State University, MF138, October 1964, 6, explains the special classification used to identify outstanding (large) farmers to be interviewed in the Kansas Area Development project.

holds will be reduced to the point where only the barest of services can be supported if all costs of the services are to be covered.

A lag exists between decline of customers in a trade area and decline in number of services offered by the trade center. Businesses do not have to cover capital costs in the short run; however, when replacement of buildings and equipment is necessary, if funds are not available, the business closes. Such a situation may be five, ten or fifteen years after the customer base has passed the critical level.

A new business (retail) that considers locating in a small town with a small trade area (customerwise) soon finds it impractical for lack of income to cover capital (fixed) costs and variable costs. Dun and Bradstreet provide evidence that every year several new businesses begin in small towns of the Great Plains, only to close down in a short time.

Despite the trends, some small towns will prosper by providing special services. However, they will be exceptions rather than the rule. In the past, the function of small towns was to supply convenience, goods and services. This function was, in general, limited to low-margin operations such as grocery stores, service stations, taverns, and eating places. Now and in the future a low-margin operation requires a high volume of business, a prerequisite that small towns cannot easily fulfill.

Special services that some small towns can and do provide develop because of their unique locations. If a small town is located near a developing resort or recreational area, or a nearby rapidly growing city, the small town can supply services and goods demanded.

Few of the small towns in the Great Plains will disappear in the foreseeable future, for they will likely be a place of residence of three types of people for several generations: (1) those who have resided in small communities for most of their lives and are unable or unwilling to move, (2) those who have retired from farms in the area and wish to remain close to acquaintances and (3) those who, while not having come from a small town, prefer to live in a small community.[20] While those conditions assure the continuance of small towns for some time, they do not make a dynamic economic climate for business.

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20. Paul W. Barkley, **The Changing Role of Some Communities In South-central Kansas,** MF93 January 1962, p. 31.
Gerald Hodges, "The Prediction of Trade Center Viability in the Great Plains," memo Nov. 15, 1964. University of Toronto, Toronto, Canada, **p. 6.**
Dwight A. Nesmith, "The Small Rural Town," **A Place to Live,** U.S.D.A. 1963 Yearbook of Agriculture, 88th Congress, 1st Session, House Document No. 29, p. 177.

APPENDIX A

Service and Trade Area Delineation

The most efficient technique to delineate service and trade areas has received the attention of many scholars in geographic and location economics. The following technique adopted for area delineation by the Area Development project was preceded by an intensive search. of the literature and by experimentation with several techniques.[1]

The criteria for an area delineation method are: It must be reliable; give comparable results for unlike areas; permit no open spaces other than lakes, sand dune areas, etc.; and be efficient. The hexagon method used in this study and others published from this research project meet those criteria. This has been ascertained in tests with other methods, some of which are reported in Appendices B and C. The required research input is greater than other possible approaches, but alternative approaches do not fulfill the above criteria.

The development and further refinement of computer graphics have the potential of minimizing research inputs and still meeting requirements. The computer method delineates large areas and regions; however, efficient use of the method has not yet been adapted to delineation of service areas for a complex of agriculturally related small towns.

Christaller, in his study on the location of cities in southern Germany, proposed that the hexagon more closely delineates the trade area of a central city than other geometrical shapes.[2] Losch reached the same conclusion. He studied the various geometrical figures that would most closely resemble a market area, the square, the circle, other polygons and the hexagon, and concluded that the hexagon was the most advantageous for studies to delineate service and trade areas.[3] Numerous recent studies have been made using various techniques for delineation, but none fits the above criteria so well as the hexagon method.

In considering the size of the hexagon to use, three factors must be considered: (1) the rural population density in each area; (2) the percentage of the people contacted in each area, or of the households used in a questionnaire; (3) the percentage response by persons contacted in each area.

If a number of areas are to be studied in a state or region, some conventions must be established for efficiency. The smaller the hexagon (areawise) used, the smoother will be the curves of delineation and the more precise the demarcations.

Southeast Kansas was the first area studied using this tech-

1. See Appendix B.

2. Mayer and Kohn, Readings In Urban Geography (Chicago: University of Chicago Press, 1959) p. 205.

3. August Losch, The Economics of Location (New Haven: Yale University Press, 1954), pp. 109-110.

nique in Kansas. The convention established was a minimum of one observation per hexagon. This minimum occurred at the margin. With this convention, most hexagons away from the margin or toward the trade center had three or more observations.

As the hexagon size was first determined for the southeast Kansas study, rural population density for that area (11.41 people per square mile) was assumed as constant in determining size of hexagons to use in studies of other areas. It is designated as a constant for other areas despite variations in population density, because the hexagon for southeast Kansas was adjusted, by experimentation, so the minimum hexagon would include at least one observation at the margin.

The following formula, set up with the above conventions, has assured at least one observation per hexagon at the margin except in areas of no population such as lakes, wasteland and large areas of grass.

Determining size of a hexagon, and adjusting size between areas of study:

Let A = Density of rural population per square mile

Let B = A constant determined by the % of the families contacted

Let C = A constant determined by the % of response

Let a = Length of side of the hexagon in inches (any unit of measurement may be used)

Let b = 11.41 = Constant rural population density per square mile

Area of hexagon = $3/2a^2\sqrt{3}$

$a^2 = \frac{area}{3/2\sqrt{3}}$

$a^2 = \frac{b/ABC}{3/2\sqrt{3}}$ b = constant = 11.41

A, B, C, being variables determining area, when area is directly proportional to rural population density.

A density of 11.41 people per square mile is assumed as a constant. A population density less than 11.41 people per square mile tends to increase the size of the hexagon to adjust for less dense population per square mile. A population density greater than 11.41 people per square mile tends to decrease size of the hexagon.

Thirty-three percent of the rural families were contacted in the Southeast Area; 100% of the rural families were contacted in the South-central Area. If a greater % of rural families is contacted, the area of the hexagon should be decreased (more observations per area). A 100% sample would be adjusted in the following way: 100%/33% = 3, 3 x the rural density of

that area would be the adjusted density of that area for computations. (For an 11% sample, $11\%/33\% = \frac{1}{3}$ x density)

The percentage response of people of the Southeast Area, 34.7% is assumed to be a constant of 1. A lower percentage response would indicate an adjusted density of less than 1, and tend to enlarge the area of the hexagon (fewer observations per area). A percentage return of more than 34.7 % would indicate an adjusted density of more than 1, and tend to decrease the area of the hexagon (more samples returned per area).

I. Southeast Area

A = 11.41

B = 1 33% of the families contacted

C = 1 34.7% response

thus $a^2 = \frac{11.41/\ [\ (11.41)\ (1)\ (1)]}{2.598} = 1/2.598 = .385$ a = .62"

II. South-central Area

A = 7.38

B = 3 100% of the families contacted

C = .75 $\frac{\text{26 \%-response of South-central Area}}{\text{34.7 \%-response of Southeast Area}}$

thus $a^2 = \frac{11.41/\ [(7.38)\ (3)\ (.75)\ ]}{2.598} = \frac{11.41/16.6}{2.598} = \frac{.69}{2.598} = .266$ a = .52"

In plotting trade areas, select the largest city of the area and center one hexagon of the latticework on it. In determining the market area surrounding this city, additional area is included with the area of the central city hexagons if:

(1) One third of the observation for the commodity in an adjacent hexagon was purchased in this central city; and the

(2) Additional hexagon had one side contiguous with hexagons already considered in the trade area.

The trade areas of other cities and towns in the area are plotted by the same method, starting with the largest city in the area.

APPENDIX B

A Test of a Method of Determining Trade Area Boundaries[1]

The hexagon method, as described in Appendix A, of determining trade-area patterns is reliable, but: it is complex and time consuming. To improve research efficiency numerous short-cut methods have been explored.

The following, reports the investigation of "Reilly's Law," a method of determining the proportions of "shopping goods" trade attracted by two cities from an intermediate town near the common boundary of the trade areas of the two cities.[2] This is an extension of Newton's "Law of Universal Gravitation" to express the "gravitation" of retail trade from an intermediate town toward two larger cities. The "law" states that the shopping goods trade attracted by two cities from an intermediate town near their common trade area boundary will be in direct proportion to their populations and in inverse proportion to the squares of the distances from the two cities to the intermediate town. It is expressed in the formula:

$$\frac{T_1}{T_2} = \left(\frac{P_1}{P_2}\right)\left(\frac{D_2}{D_1}\right)^*$$

*$T_1 + T_2 = 100\%$ trade leaving intermediate city. T_1 can be solved by merely substituting value of T_2 in terms of T_1 to reduce equation to the unknown.

where T_1 and T_2 are the proportions of trade drawn by the two cities from the intermediate town, P_1 and P_2 are the populations of the two cities, and D_1 and D_2 are the distances from the cities to the intermediate town.

A derivation of Reilly's Law was developed by H. M. Sweet, a student at the University of Illinois.[3] His formula is a method of determining the breaking point between the trade areas of two cities. It can be expressed as follows:

$$\text{Breaking point, miles from B} = \frac{\text{Miles between A and B}}{1 + \frac{\text{Population of A}}{\text{Population of B}}}$$

where A is the larger town and B the smaller town.

This formula was tested using data from Iowa trade centers gathered in 1935 and 1949.[4] It was found that the formula

1. Jane Sears, ResearchAssistant formerly with the Department of Economics, Kansas State University.

2. William J. Reilly, **The Law of Retail Gravitation** (New York: William J. Reilly Co., 1931).

3. P. D. Converse, "New Laws of Retail Gravitation," **Journal of Marketing.** Vol. XIV, No. 2, October 1949. P. D. Converse and Harvey W. Huegy, **The Elements of Marketing** (New York: Prentice Hall, Inc.,1952, p. 388).

4. Robert B. Reynolds "A Test of the Law of Retail Gravitation," **of Marketing,** XVII:3 (January1953), pp. 273-277.

did not hold in Iowa in 1936, but the 1949 data supported it for certain shopping items (women's coats, men's good shoes, farm machinery) and, to some extent, groceries.

Sweet's formula was tested to determine its reliability as a method of determining trade area boundaries in Kansas. The method of testing the formula is almost identical with that used by Reynolds[5] mentioned above. Statistical tests used were linear regression and analysis of covariance.

Data for the test were obtained from trade area studies conducted through the Kansas State University Area Development research project from 1960 to 1962. Studies were conducted in four areas of Kansas, each consisting of several counties and containing at least two major shopping centers as well as several smaller trade centers. Trade areas were delineated using information obtained from post card surveys of rural residents. The formula was tested for five goods and services: banking, farm machinery, physician's service, food, and clothing. Table 1 gives the number of pairs of towns in each subgroup in the total sample.

Sweet's formula can be stated algebraically as:

$$d_2 = \frac{d_1 + d_2}{1 + \sqrt{\frac{P_1}{P_2}}}$$

From this the formula to be tested was algebraically derived:

$$\frac{d_1}{d_2} = \left(\frac{P_1}{P_2}\right)^{.50} \qquad \text{or} \quad D = (P)^{.50}$$

where d_1 is the distance of the trade area boundary from the larger town and d_2 from the smaller town. P_1 is the population of the larger town and P_2 of the smaller town. D and P symbolize those ratios.

The hypothesis to be tested is: "The ratio of the distances from the trade area boundary to the two towns is directly proportional to the square root of the ratio of their populations." The figure to be tested, then, is the exponent of P.

Values of P and D were plotted graphically and it was decided that the theoretical power best fit the data. Logarithms were taken of P and D and the data analyzed using the least-squares method to find b in the formula log D = b log P. If b was not significantly different from .50, Sweet's formula survived the test.

5. Ibid.

Table l.-Number of observations by subgroup.

Subgroup	Number of pairs of towns
Banking	24
Farm machinery	32
Physician's service	29
Food	25
Clothing	26
Southeast Kansas	28
South-central Kansas	15
Southwest Kansas	51
Northwest Kansas	42
Total sample[1]	136

1. The number of paired towns in the total sample is equal to half the total of the subgroups because each pair of towns was placed in a "goods and services" subgroup and an "area" subgroup.

Table 2 shows the values of b obtained in the separate linear regression analysis of each product or service and each area. Analyses of covariance among goods and services and among areas showed, in both cases, that populations may have the same regression line, so b for the total sample was also computed and is included in Table 2.

Using the t test, farm machinery was the only subgroup whose b value differed significantly from B = 50 at the .05 level. Although a glance at Table 2 shows a fairly wide range of b values and very wide confidence intervals, the formula was not disproved statistically for most subgroups.

The coefficients of determination or correlation coefficients

Table 2.--Values of b for subgroups and the total sample.

Subgroup	b	.05 confidence interval
Banking	0.308	B > 0.062 or < 0.664
Farm machinery	0.107[1]	B > -0.127 or < 0.341
Physician's service	0.355	B > -0.097 or < 0.807
Food	0.360	B > 0.045 or < 0.674
Clothing	0.860	B > 0.321 or < 1.380
Southeast Kansas	0.549	B > 0.092 or < 1.005
South-central Kansas	0.885	B > -0.892 or < 2.662
Southwest Kansas	0.350	B > 0.192 or < 0.608
Northwest Kansas	0.284	B > -0.218 or < 0.786
Total sample	0.394	B > 0.220 or < 0.667

1. Significant at .005 level.

Table 3.-Values of r^2 for subgroups and the total sample.

Subaroup	r^2	.05 confidence interval
Banking	.235*	$r^2 >$ .010 or < .554
Farm machinery	.088	$r^2 >$ 0 or < .341
Physician's service	.088	$r^2 >$ 0 or < .358
Food	.196*	$r^2 >$ .004 or < .510
Clothing	.315**	$r^2 >$ .049 or < .605
Southeast Kansas	.190*	$r^2 >$ .006 or < .740
South-central Kansas	.082	$r^2 >$ 0 or < .486
Southwest Kansas	.289**	$r^2 >$ .094 or < .501
Northwest Kansas	.032	$r^2 >$ 0 or < .209
Total sample	.131**	$r^2 >$ .042 or < .249

- Significant at .05 level.
- * Significant at .Ol level.

squared tell a different story. Table 3 shows the value of r^2 obtained for each subgroup and for the total sample.

The coefficient of determination is a measure of "goodness of fit" to the regression line. It gives the proportion of variance in log D associated with variance in log P. An r^2 of 1.000 would indicate a perfect fit to the regression line or all of D being associated with or "determined" by P. An r^2 of 0.000 would indicate no fit to the regression line, or all of D being "determined" by factors other than P. Although most were found to be significantly different from 0, all values of r^2 were low and had wide confidence intervals.

The r^2 for the total sample, 0.131, can be interpreted to mean that 13% of the ratios of the distances from the trade area boundaries to the two towns can be explained by a function of the ratios of their population. The largest value of r^2 (for clothing) can be interpreted to mean that 32% of "distance" can be explained by "population" for clothing. In general most of "distance" is explained by factors other than "population."

In summary, the theoretical function of B = 0.5 was not disproved, although a wide range of b values was obtained for the subgroups. The small number of observations made it necessary for b to deviate farther from the theoretical value of B to reject the null hypothesis than would be required with a larger sample. The wide confidence intervals, to some extent, also result from small sample size.

The coefficient of determination showed positive correlation between distance and population for the total sample and for most of the subgroups. This correlation was low, however, and indicated other factors than population ratios affect location of trade area boundaries.

The original "Reilly's Law" and the derived formula tested here were intended for use on the trade areas of shopping goods only. Of the goods and services examined in this paper,

clothing is probably the only true example of a shopping goods. Clothing has the highest value of b and r^2, as expected.

Farm machinery and physician's service have the lowest values of r^2, not significantly different from 0. In addition, farm machinery has a b value not significantly different from 0. For farm machinery, this might indicate that factors other than population account for trade area boundaries.

Physician's service has a wide confidence interval for b and its r^2 is not significantly different from 0. This indicates a poor fit to the regression line and factors other than population determining trade-area boundaries. The so-called Kansas plan to get doctors to locate in small Kansas towns has no doubt improved medical services of small towns and helped them draw patients. The nature of the services makes proximity of doctor and patient important. Such factors favoring small towns, together with differences in quality among doctors and absence of specialists in small towns, account for the low value of r^2. Apparently town population is at best a minor factor in selecting a physician.

The relatively low value of b and the nonsignificant value of r^2 for the northwest Kansas area can be at least partially explained by the geography of the area. It is characterized for the most part by county seat towns located in the center of the county and drawing most of the trade from that county. Distances to a larger town are much longer than in eastern Kansas. The geographical pattern pressures customers to demand a wider range of goods and services than in towns of the same size in more densely populated parts of the state. The variety offered, in turn, strengthens the drawing power of the towns.

The nonsignificant value of r^2 and the high value of b for the south-central area are the result of high standard error of the regression coefficient. The extremely wide confidence interval for b shows no information of any value for this area.

Although Sweet's formula was not statistically disproved in most cases, the low values of r^2 and the wide confidence intervals for b indicate that many factors other than population are important in determining trade-area boundaries in Kansas. It is possible that a more complex formula including other factors might be developed to result in a better fit to the regression line. The present formula, however, should not be used to set up trade-area boundaries in future study areas because of the high probability of inaccuracy in individual cases.

Sweet's extension of Reilly's Law was not disproved in the aggregate, but was shown to be unsatisfactory in individual cases. Since the individual case is the object of interest in trade-area studies, each set of boundaries should be determined empirically. The theoretical method, in this case, did not prove to be a reliable basis for prediction.

APPENDIX C

Comparing Trade Area Delineation Methods

In 1960, businessmen in south-central Kansas who derived a majority of their gross dollar volume from farm trade were interviewed. That study, briefly described here, provided an alternative way of delineating a trade area.

Each businessman was asked to outline his trade area on a map (½ inch = 1 mile). The outline was obtained by using a minimum of eight points of the compass (N, NE, E, etc.). The respondent was instructed that he was not to give points from which the most distant customers came, but to establish points where his customers become sparse.[1]

The composite trade area, Figure 5, represents the Little

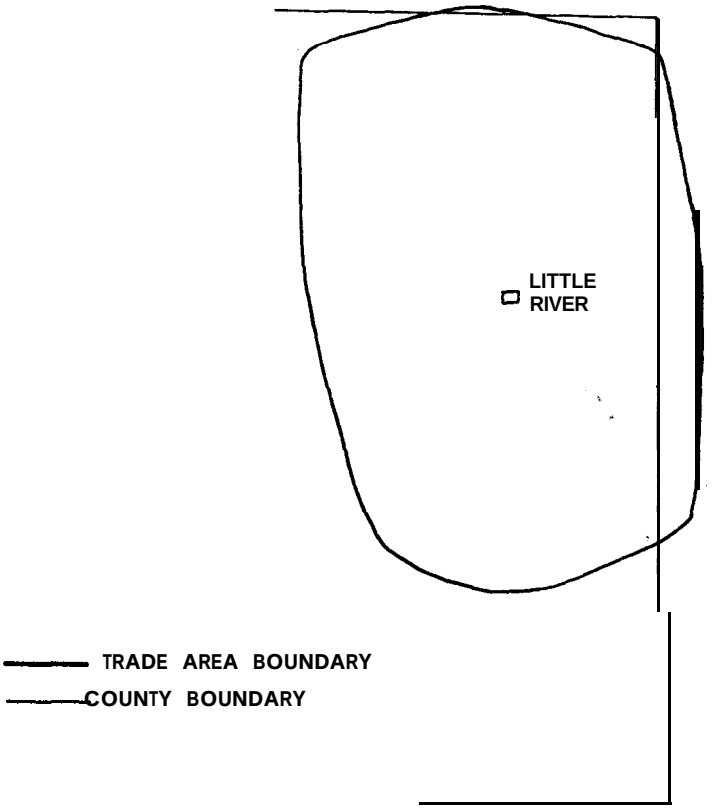

Fig. 5.-Composite Trade Area (Area of 256.6 square miles) as indicated by four Little River businessmen interviewed in 1960 concerning their trade areas and the business climate of the community.

1. R. D. McKinney et al., **Some Economic Impacts of Water Reservoir Development,** Manhattan, Kansas; Agricultural Experiment Station, Kansas State University, Agricultural Economics Report 106, June 1966, pp. gives a more complete description of the method .

River trade areas as defined by businessmen. The composite trade area was derived by averaging their answers on eight points of the compass.

Comparing this method of trade-area delineation to the method using post card survey-hexagon plotting (as described in Appendix A) indicates either that the post card survey approach estimates trade area of a business center or commodity on the conservative side or that businessmen are overly optimistic regarding boundaries of their trade areas. Additional studies and comparisons of businessmen's responses in southeast and southwest Kansas gave similar variations.

The card survey approach, compared with interviewing businessmen to delineate trade areas, was more efficient and provided both more observations and greater precision at the margin. The card survey method also gives a more precise view of trade-area complexes or areas in transition. Businessmen interviews were put into the original trade area study design to test procedures and methods of analysis. The tests and comparisons were carried in the study of four areas of the state. Comparisons of the two methods were carried on at the commodity or service area level for a number of studied business centers of varying sizes. Since 1963, trade-area studies in Kansas have been carried out using only the card survey approach. It was selected only after the completion of several tests as outlined in the appendix, and other studies of the type reported in Appendix B.