



ABSTRACT

PROJECTION OF 1980 RETAIL FOOD SALES IN MICHIGAN

by

Kenneth Delmar Duft

During the 1950 to 1962 period, the state of Michigan experienced over a 40 percent increase in the volume of retail food sales. However, some counties doubled their sales during this same period while others increased only slightly.

The problem, therefore, lies in the Michigan retail food industry's need to accurately project the potential gross food sales of a given geographical area (i.e., county) so as to recognize and make the necessary changes in their expansion plans. This need may arise due to the lack of necessary information, but more often can be attributed to the lack of knowledge about the socio-economic causal relationships affecting changes in the magnitude of an area's gross food sales.

Therefore, the basic objective of this study was to determine relationships and significance, if any, of economic and sociological factors in explaining variations in gross retail food sales over time by county, metropolitan area and state. The secondary goal was then to formulate basic statistical procedures that would use these relationships to accurately project the potential retail food sales volume for a given area up to the year 1980.

The technique used to reach the objectives was that of statistical analysis and projection based on regression equations.

Multiple linear regression equations were used to determine what relationships, if any, did exist between county retail food sales (dependent variable) and various market characteristics such as population, income, etc. (independent variables). Variations in county and state retail food sales for the years 1951-62 were used. Eight independent variables were used in the first trial run. After each trial, those independent variables with high intercorrelation and/or a low degree of significance were eliminated. County population, per capita disposable income, and number of retail food stores per county were the three independent variables remaining after the third trial. Population was found to be of such great importance that it tended to hide the relationships of the other two variables. The dependent variable was then changed to per capita retail food sales, thereby leaving per capita disposable income and number of food stores as the independent variables. Retail food sales and per capita income were deflated by a food price index and consumer price index, respectively, to eliminate inflationary price fluctuations.

Once the effects of these two independent variables had been determined, a simple curvilinear regression equation was used to project the expected value of these two variables into 1980 (time used as independent variable). These projected

The first part of the paper is devoted to the study of the properties of the function $f(x)$ defined by the equation

$$f(x) = \int_0^x \frac{1}{1+t^2} dt, \quad x \in \mathbb{R}.$$

It is well known that this function is the arctangent function, i.e., $f(x) = \arctan x$. The main result of this section is the following theorem:

Theorem 1. Let $f(x)$ be the function defined by the equation (1). Then the function $f(x)$ is strictly increasing and concave down on the interval $(-\infty, \infty)$.

The proof of this theorem is given in the next section. The second part of the paper is devoted to the study of the properties of the function $g(x)$ defined by the equation

$$g(x) = \int_0^x \frac{1}{1+t^4} dt, \quad x \in \mathbb{R}.$$

It is well known that this function is the function $g(x) = \frac{1}{3} \arctan x$. The main result of this section is the following theorem:

Theorem 2. Let $g(x)$ be the function defined by the equation (2). Then the function $g(x)$ is strictly increasing and concave down on the interval $(-\infty, \infty)$.

The proof of this theorem is given in the next section. The third part of the paper is devoted to the study of the properties of the function $h(x)$ defined by the equation

$$h(x) = \int_0^x \frac{1}{1+t^6} dt, \quad x \in \mathbb{R}.$$

It is well known that this function is the function $h(x) = \frac{1}{5} \arctan x$. The main result of this section is the following theorem:

Theorem 3. Let $h(x)$ be the function defined by the equation (3). Then the function $h(x)$ is strictly increasing and concave down on the interval $(-\infty, \infty)$.

The proof of this theorem is given in the next section. The fourth part of the paper is devoted to the study of the properties of the function $k(x)$ defined by the equation

$$k(x) = \int_0^x \frac{1}{1+t^8} dt, \quad x \in \mathbb{R}.$$

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values could then be inserted into the multiple linear equation for a given county and a projection of that county's per capita retail food sales calculated. Each county's population was then projected, using a geometric-linear expansion, so the per capita sales projection could be converted into total county projections. This entire process was conducted with five selected Michigan counties and the necessary data on the remaining 78 counties presented in the appendix.

On the basis of this research, the following conclusions can be drawn:

- 1) The major factor in determining the volume of a county's retail food sales is that county's population. However, variations in per capita deflated retail food sales are largely explained (R^2 of .13 to .85) by per capita deflated disposable income and the number of retail food stores in the county.
- 2) The effect of the number of stores was negative for the majority of the counties. The magnitude of this effect was greatest in the northern counties and diminished as one moved down to the southeast counties where the coefficient was slightly positive. This phenomena is partially explained by the northern counties experiencing a huge decrease in the number of small rural stores, giving the few remaining large stores greater drawing power. However, the southeast counties experienced this sharp decrease in numbers of small stores prior to the observation period and therefore, the small increase in number of large stores slightly increased per capita sales due

to increased product availability, etc.

3) The state, as a whole, was found to have a positive income effect. Income was expected to exert a positive influence upon per capita food sales, however, 34 of the 83 counties produced negative coefficients. Additional study is needed to explain this unexpected phenomena. Findings showed the income elasticity of the demand for food to be lower in those counties with higher per capita income, therefore, being consistent with Engel's Law.

4) The significance, magnitude and direction of the effect the independent variables had on per capita retail food sales varied greatly throughout the state.

5) The projection technique used in this paper proved to be more practical, realistic, and applicable when compared to the normally used simple curvilinear projection over time.

6) Projections indicate a 150 percent increase in Michigan's gross retail food sales by 1980.

PROJECTION OF 1930 RETAIL FOOD SALES IN MICHIGAN

By

Kenneth Delmar Duft

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A PROJECTION OF 1980 RETAIL FOOD SALES IN MICHIGAN

CHAPTER I

INTRODUCTION

Retail food marketing occupies a very strategic position in the American economy. Its gross annual sales - currently over \$56 billion (nationally) - are greater than those of any other American industry.¹ Approximately one-fifth of every dollar spent by American consumers is spent at a food store.² The farming sector of our economy, as well as food processors, is greatly dependent on the retail food industry as a market outlet for their products.³

Within the retail food industry, grocery retailing constitutes the most important segment. Nationwide, grocery stores accounted for 73 percent of all retail food stores and 87 percent of all retail food sales in 1961. And, grocery store sales are growing more rapidly than total food sales.

¹"Industry," defined as a business which employs much labor and capital and is a distinct branch of trade i.e. comparison based on the dollar volume of annual retail sales of the manufactured product.

²Economic Report of the President, Government Printing Office, 1960, pp.18 (all such data are estimates for 1959 made by the Council of Economic Advisors).

³Willard F. Mueller and Leon Garorian, Changes in the Market Structure of Grocery Retailing, Univ. of Wisc., Madison, 1961, pp.2.

This increasing importance of grocery store business relative to the entire retail food industry, is due primarily to its expansion into a wide offering of both food and non-food items.⁴

Just as the retail food industry is of major importance to our nation's economy, it is also of major prominence in the state of Michigan. The importance of the retail food industry to Michigan's economy is second only to the massive automobile industry. Between the years of 1951 and 1962, gross retail food sales in Michigan increased from \$2.33 to \$3.55 billion, or almost 50 percent.

Table 1. Total Annual Michigan Gross Retail Food Sales, 1951-62

(\$000)	
1951 - 2,379,817	1957 - 3,202,872
2 - 2,538,447	8 - 3,264,480
3 - 2,703,329	9 - 3,255,889
4 - 2,852,181	1960 - 3,374,681
5 - 2,858,462	1 - 3,337,483
6 - 3,104,606	2 - 3,357,808

This paper is devoted to a description, explanation, and projection of past, present and future changes within the Michigan retail food industry.

⁴Economic Report of the President, p. 8.

RECENT STRUCTURAL CHANGES:

Despite the immense expansion of gross sales during that twelve year observation period, the number of establishments acting as outlets for food products continually decreased. The number of retail food stores in Michigan decreased from 16,531 in 1951 to 11,572 in 1962 or 30 percent.

Table 2. Number of Retail Food Stores in Michigan 1951-62.

1951 - 16,531	1957 - 13,781
2 - 15,872	8 - 13,529
3 - 15,210	9 - 13,017
4 - 14,548	1960 - 12,503
5 - 14,292	1 - 12,039
6 - 14,037	2 - 11,572

This illustrates how those stores remaining are experiencing a continued increase in gross sales per store. In 1960, 72 percent of the remaining food stores in Michigan were grocery stores and 74 percent of food sales were grocery store sales.

Following is a list of additional possible reasons for the increase in per store gross retail food sales:

- 1) Business captured by the large food stores from the smaller and usually less efficient food retailer. Table 3 shows how the large volume store has become more dominant.
- 2) Population increases, as shown in Table 4. (Increase in population density implied)

Table 3. Michigan Food Store Numbers by Sales Volume¹

Sales Volume (\$)	1954		1959		1960	
	Number of Stores	Percent of Total	Number of Stores	Percent of Total	Number of Stores	Percent of Total
Up to 500,000	13,871	95.35	12,505	92.92	11,374	90.82
500,000 to 1 million	313	2.15	409	3.00	487	3.88
1 million and over	363	2.50	555	4.08	662	5.20
Total	14,548	100.00	13,529	100.00	12,523	100.00

Table 4. Michigan Population 1951-62².

(000)

1951 - 6,516.9	1957 - 7,387.8
2 - 6,662.1	8 - 7,532.9
3 - 6,809.2	9 - 7,678.1
4 - 6,952.3	1960 - 7,823.2
5 - 7,097.5	1 - 8,038.4
6 - 7,242.6	2 - 8,265.9

¹Kenneth D. Duft, and Earl H. Brown. "Michigan's Retail Food Industry - Statistics on Population, Store Numbers and Sales, by State, County, and Metropolitan Areas," Michigan State University, Agriculture Economics Department, June 10, 1963.

²United States Population Census of Michigan, U.S. Dept. of Commerce, 1960.

3) Changing food preparation and buying habits of the consumer, i.e., purchases of more costly prepared foods.

Using the classical example of the "T.V. Dinner," where the meal is prepared except for heating, we can easily see how the increased cost at the retail food store might produce indications of increased gross sales volume. Gone are the days when the housewife went to the live chicken market to pick out the bird, then take it home for plucking and evisceration. Gone are the days of washing and out of spinach, taking the pail down to the milk store, waiting for the grocer to measure out the potatoes and apples from a barrel.¹

4) Addition of non-food items.

According to one national study, the average food store now stocks 13 out of 21 major non-food or general merchandise lines. Health and beauty aids, housewares, and women's hosiery are the three leading lines (handled by over 90 percent of the food stores).² In 1958, 5.20 percent of total sales in the average food store were derived from the sale of non-foods.³ In 1963 a study by home economists at Purdue

¹"Fact Book on United States Agriculture," U.S. Dept. of Agriculture, Office of Information, March 1963, pp.68-9.

²"Food Chains Put the Old General Store Back on the Map," Business Week, April 4, 1959, pp. 92-4, 99.

³"Facts in Grocery Distribution," Progressive Grocer, 1959.

University showed that non-foods made up 20 percent of the supermarket purchases in Lafayette and Indianapolis, Indiana.¹

It has often been stated that expansion and progress are little more than necessary by-products of a capitalistic society. Many, if not most food store operators feel that growth of their companies is an essential element in continued business success. One supermarket executive has argued - correctly in my opinion - that if business does not progress, it will retrogress, that it cannot stand still. The reason for this he argues, is that a store which is not growing finds it difficult to retain young and ambitious personnel, but even more important, an enthusiastic spirit is often nurtured by growth and such spirit is hard to generate in a static organization.²

The recent growth in Michigan's retail food industry can also be attributed to the existing market conditions, i.e., competitive structure, profits, etc. Economic theory assumes that industry adjusts, grows, and also declines in order to increase or secure their profit position.³ Here we

¹"Fact Book on U.S. Agriculture," pp. 68-9.

²Ralph Cassidy Jr., Competition and Price Making in Food Retailing, University of California, Los Angeles, 1962, p. 43.

³Ibid., p. 43.

shall cite several reasons associated with increased horizontal integration which seems to have a bearing on the situation in Michigan during 1951-62.¹

Economies of Scale -- advantages such as specialized management, large scale procurement of supplies, and greater ease in obtaining equity and loan capital.

Geographic Diversification -- integration over a large geographic area increases a firm's security or survival power, i.e., poor operating conditions in one area may be counterbalanced by more satisfactory ones elsewhere.

Prestige -- management of large firms may desire to grow ever larger in order to enjoy the prestige associated with operating one of the state's largest firms.

Market Power -- horizontal integration may proceed to the point where it results in a high degree of market concentration; allowing those larger firms to have some control of their selling and/or procurement policies.

In Michigan, as was true throughout our nation during this time period, the small sized retail food outlets were "squeezed" out of business by the large affiliated chains. So as to increase their competitive positions against the large organization, many of those remaining small outlets merged

¹Beginning with Jan, 1963, Supermarket News.

together. There are several basic factors which made growth by merger preferable to growth through internal expansion.

Market Structure Considerations -- since it may be extremely difficult to open a number of stores in a new market in a relatively short period, a firm desiring to expand has an important incentive to do so through the merger route.

Financial Considerations -- buying a going concern often is easier to finance than is internal growth on a comparable scale.

Tax Incentives -- popular literature on mergers often cites the tax structure as an important incentive for mergers. Under certain conditions, an acquiring firm gets not only the assets of another concern, but its tax losses as well.¹

In the above discussion, I have presented some basic data in conjunction with a short explanation of recent changes within the Michigan retail food industry and its market structure. During this period of structural re-arrangement, progress has been made and must continue to be made. It has been shown that continued economic progress cannot be made within a static industry and, therefore, we must anticipate and prepare for many more changes in the future. This situation can best be described by quoting a statement from the

¹"The Merger Movement in Retail Food Distribution," National Association of Retail Grocers, Chicago 1959, pp.25-7.

conclusion of Ralph Cassidy's text, "Since no one knows definitely what will happen next, those engaged in business in this field must figuratively be 'on their toes'. This requires being mentally alert to change and flexible-minded regarding the form that such changes take. In short, those in this field must be willing and able to move with changing needs and conditions of those composing the market, because food buyers will be with us always, while the food store might in time be replaced by some other type of organization."¹

Therefore, as stated by Ralph Cassidy, the retail food industry must remain flexible and able to adjust its food distribution duties so as to meet the changing needs and composition of those composing the market. This leads us directly into the primary problem to be dealt with in this paper - that of accurately forecasting those areas of expansion and contraction to which the retail food industry must make its adjustments.

Recently Mr. Curt Kornblau, Director of Research of the Supermarket Institute, while speaking on the retail food industry's failure to accurately predict the potential sales volume of tentative food store sites, stated, "Nearly two out of every three new supermarkets (62 percent) are doing less business than predicted.... The difference between actual and estimated gross food sales is quite substantial; in many cases ranging from 54 percent below to 49 percent above. Due

¹Cassidy, p.274.

to heavy reliance being placed upon intuition and rules of thumb, decisions concerning future store expansion and site selection have been made on promotional differentiation rather than economic justifications.¹

Even though Mr. Kornblau was referring to national data, this same problem exists within the Michigan retail food industry.

IDENTIFICATION OF THE PROBLEM:

The problem, as found in other states as well as Michigan, lies in the retail food industry's inability to accurately project the potential gross food sales of a given geographical area so as to make the appropriate adjustments in their future expansion plans. This inability may be due to the lack of necessary information, but more often can be attributed to the lack of knowledge about the socio-economic causal relationships affecting the magnitude of an area's gross food sales. Even for those few who have an understanding of the basic relationships involved in determining the volume of potential gross food sales, there seems to be a lack of ability to transpose this knowledge into workable, meaningful, and accurate projections.

¹Curt Kornblau, Director of Research, Supermarket Institute, from a paper presented on Nov. 1, 1963 in the Kellogg Center, Michigan State University, East Lansing, Michigan, to a food marketing seminar.

A voluminous amount of information has been published concerning the optimal store location within a given town or city, however, most all such writings assume the area, county, and city have already been selected and the decision already made to build a new store.¹ Thus, the main problem still remaining is that of analyzing the local environment factors in an attempt to locate these market characteristics normally contributing to the maximization of an area's expected profit potential. Little regard, if any, is ever given to determining in what general area or county an additional outlet is most needed, either now or in the future. For example, a new retail food store may be experiencing 40 percent less business than anticipated. The store may exist in a city previously shown to have adequate sales potential and it may be located in an ideal area. The problem here may be:

- 1) Those investigating the sales potential of this locale failed to discover any trends indicating that the potential sales were likely to decline in the future, or
- 2) Those investigating failed to extend their study into an area any larger than the city itself and thus failed to discover an extremely low buying potential in the county or general area surrounding the city.

In order to avoid such errors, an entire state, area and

¹M. G. Gibbs. "How a Prominent Chain Picks its Store Locations," Printer's Ink, Vol. CXLI Nov. 10, 1947, pp. 108-9.

county must first be analyzed and all trends projected into the future (at least 10-15 years) before deciding if and where expansion (or contraction) is necessary for the retail food industry to meet the changing demands and market conditions.

Other related problems may be summarized as follows:

- 1) Lack of basic long run sales potential data projections, which are necessary for sound future planning by the Michigan retail food industry.
- 2) General lack of knowledge necessary to understand and interpret future trends and apply this data in a practical decision making situation.
- 3) Lack of area and county trend data, necessary in analyzing future potential sales changes within counties and necessary in food store expansion, contraction, re-location, etc, thereby implied.
- 4) Lack of true understanding of the effect income, market saturation, population and other significant related variables may have on past, present, and future gross retail food sales.

DEFINITION OF TERMS:

Before continuing any further, it would be most beneficial to the reader to clearly define those terms that were used and/or will be used in this paper.

Supermarket - a highly departmentalized retail establishment, dealing in foods and other merchandise, either wholly owned or concession operated, with adequate parking

space, doing a minimum of \$500,000* business annually. The grocery department, however, must be on a self-service basis.¹

Metropolitan Area - A specific geographical area based on criteria presented in 1960 U.S. Census of Population and summarized in Sales Management.²

Michigan has ten metropolitan areas (as classified by the U.S. Census criteria). The metropolitan area statistics used in this study, were aggregated from the county data presented in the 1960 U.S. Population Census of Michigan. Each metropolitan area consisted of the following county (or counties).

<u>Metropolitan Area</u>	<u>Counties</u>
Ann Arbor	Washtenaw
Bay City	Bay
Detroit	Wayne, Oakland, Macomb
Flint	Genesee
Grand Rapids	Kent
Jackson	Jackson

*Revised from \$250,000. annual sales in 1961 by the Supermarket Institute.

¹Robert L. Clodius and Darrell F. Fienup and R. Larry Kristyanson, "Procurement and Practices of a Selected Group of Dairy Processing Firms," Research Bulletin 193, University of Wisconsin, Jan. 1956, p.2.

²"Metropolitan Area Summaries," Sales Management, June 10, 1962, pp. 393-5.

<u>Metropolitan Area</u>	<u>Counties</u>
Kalamazoo	Kalamazoo
Lansing	Clinton, Eaton, Ingham
Muskegon	Muskegon
Saginaw	Saginaw

Map No. 1 locates these ten areas.

Food Store - The following were considered as food store establishments;¹

Grocery stores - with or without meats

Dairy Product stores - milk markets

Fruit and Vegetable stores

Restaurants (family) *

Taverns, Clubs *

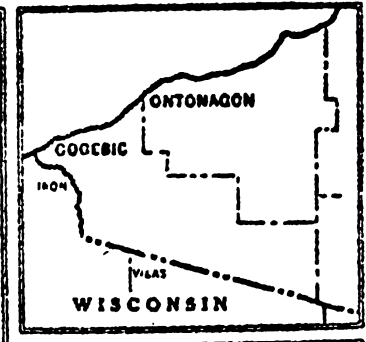
Miscellaneous - candy stores, bakeries, egg and poultry markets, delicatessen, other.

Store Complex - Refers to the complex of stores surrounding the proposed store location. When used in references to shopping centers, it connotes the complete range of stores within the individual shopping center. When used in reference to unplanned sites, it refers to the retail stores located within one-third mile of the site. When used in reference to a small town,

¹U.S. Business Census, U.S. Department of Commerce, 1949, 54, 58.

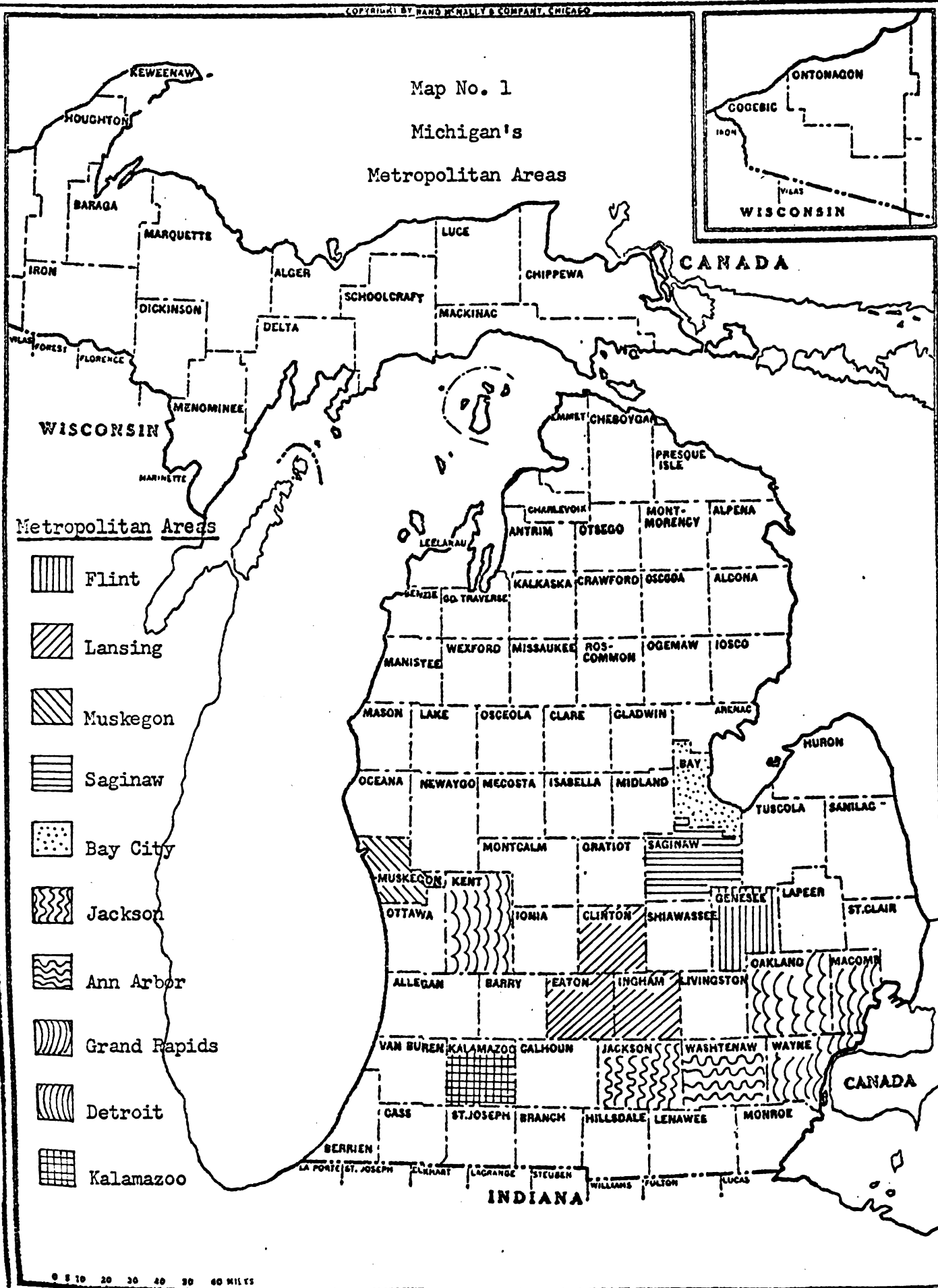
* These categories are to be considered only when considering sales volume data; not included in numbers of stores.

Map No. 1
Michigan's
Metropolitan Areas



Metropolitan Areas

- Flint
- Lansing
- Muskegon
- Saginaw
- Bay City
- Jackson
- Ann Arbor
- Grand Rapids
- Detroit
- Kalamazoo



it refers to all of the retail stores comprising the business district of the town.

Isolated Retail Unit - Retail food outlet existing with no other retail stores around it on what is often called a "free standing location."

Market Concentration - The extent to which sales in a particular market area are channeled through a certain firm or number of firms.

Rural - Pertaining to areas with no incorporated villages of 2,500 population or more.¹

Market Saturation - Measured by the number of retail outlets within a given geographical area.

Tourist Day - The period of one day spent by one tourist in a given area.²

Inter-correlation - Simple statistical correlation between two or more of the independent variables of a regression equation.

BASIC OBJECTIVES:

1) To determine relationships and significance, if any, of economic and sociological factors in explaining variations in gross retail food sales over time by county, metropolitan area and state (Michigan).

¹U.S. Population Census.

²Reinhold, P. Wolff. "Estimating the Market Potential of a Floating Population," Journal of Marketing, July 1954, 19:12-17.

- 2) To determine significance of related factors in explaining variations in gross retail food sales among Michigan's eighty-three counties over the years 1951-62.
- 3) To formulate basic statistical procedures that would use the relationships determined in (1) and (2) to accurately project the potential food sales volume by county, metropolitan area and state (Michigan) up to the year 1980.
- 4) To predict the proportion of the projected gross annual sales volume which will be associated with different types of retail food stores, i.e., grocery store, dairy product store, restaurants, etc.
- 5) To derive, explain and analyze income elasticity for the demand for food in Michigan during the twelve year period under investigation.
- 6) To analyze results and convert projections into practical suggestions of how this data might be applied by the Michigan retail food industries in their future planning.

GENERAL HYPOTHESES:

The major hypothesis is: Once the significance of economical and sociological factors effecting gross retail food sales have been determined, statistical concepts such as multiple linear regression and simple curvilinear regression may be applied to accurately project into the future potential gross retail food sales by county, metropolitan area and state of Michigan. This statement, then, posits that accurate projections can be made, enabling the retail food

industry to evaluate and adjust their expansion plans on a scale larger than a single business district.

To be more consistent with normal statistical reasoning, the above hypothesis could well have been stated in the form: The effect socio-economic factors have on gross retail food sales cannot be determined and statistical techniques such as regression analysis cannot be applied to accurately project potential gross retail food sales for a given area. A null hypothesis such as this may seem more meaningful to the reader with a strong statistical background.

Some sub-hypotheses are:

- 1) The proportion of total gross retail food sales attributed to grocery stores will change only slightly in Michigan's near future.
- 2) Despite the enormous emphasis placed on the measurement of the income elasticity of the demand for food on the national and state basis, a much more detailed analysis is necessary before this national measurement can accurately be applied to an individual area as small as a county.
- 3) The relationships found between variable factors and gross retail food sales varies so greatly among the eighty-three Michigan counties that an individual county analysis must be conducted to obtain accurate and applicable results.

METHODS OF INVESTIGATION:

So far in this chapter, I have attempted to illustrate the importance of the retail food industry and formulate the

objectives and hypotheses of this paper.

In Chapter II of this paper, short summaries of previous studies conducted in the area of retail food market potentials and other related subjects are presented. It is hoped that these resumes provide background knowledge for a better understanding of the reasoning and procedures used later. Each resume contains the general purpose of the study, a short description of procedures used, conclusions or results, and an explanation of how this study's techniques or results were applicable or helpful to the discussion of the problem dealt with in this paper.

The first major problem that must be considered is the determination of which variables significantly effect the volume of gross retail food sales. Chapter III contains a discussion and explanation of the possible effects various factors may have on gross sales. Final selection of those factors to be used in the final statistical computations will be made on the basis of trial run statistical results and the findings of past studies in this particular area.

Following this comment on possible sales determinant factors, the techniques used to obtain the information necessary for a study of this nature will be discussed. Explanations will be given, when necessary, concerning the validity of the data accumulated and adjustments made to render the data more representative of a true situation.

Chapter IV contains an enumeration of the possible statistical procedures which could be used in such an analysis. Included is a short explanation of the advantages and disadvantages of alternative methods, followed by a justification for the selection of the regression analysis technique. The basic procedures, and computations shall then be interpreted. For purposes of simplicity, this interpretation will not consist of a detailed analysis of the regression technique, but will explain only those concepts necessary for an understanding of the results derived.

Chapter V deals with the actual execution and application of the accumulated data to the statistical routine. Here it is shown how over a series of "trial runs," the insignificant variables (factors) were dropped, the intercorrelation and trend eliminated, and the final formula derived. Assertions of expected results are made to form a basis for later contradictions and illustrations of the heterogeneous results among Michigan's counties.

In Chapter VI the results of the time series and cross sectional studies, using the multiple linear regression, are presented. Rather than burden the reader with results of the statistical tests of all eighty-three Michigan counties, five counties (representing geographical and demographical extremes) were selected. For the more avid reader, data on the other seventy-eight counties is available in the appendix of this paper.

The coefficient estimates from these same five selected counties are then analyzed so as to give the reader an idea of the basic procedure used without boring him with repetitive county analysis. County data is compared with the results of the state, as a whole, and additional comments made, concerning Michigan's ten metropolitan areas.

Following the presentation and interpretation of these results in Chapter VI, this information is then applied to a regression equation to form the actual retail food sales projections into the year 1980. Values of the independent variables are projected on the basis of simple curvilinear regressions, and these results applied to the multiple linear regression equations, producing the projected potential food sales volume by county, metropolitan area and state for 1980.

The use of these projections in decision making processes concerning location of and/or need for additional retail food outlets throughout the state of Michigan is illustrated in Chapter VIII. Next, the limitations of this type of study are recognized and discussed. Suggestions are made concerning adjustments that might eliminate many of the deficiencies.

An acceptance or rejection of the major and sub-hypotheses is made in Chapter IX. It also contains a summary and concluding statement pertaining to the effectiveness and applicability of this paper's results to the major problem as stated in this chapter.

CHAPTER II

POSSIBLE PAST CONTRIBUTIONS TO THIS STUDY

This chapter contains short resumes of studies previously conducted that are related to the problem dealt with in this paper. Many of these contributions will be referred to later to provide background for various statements.

Foundation Study

In 1954 Robert Ferber of the Department of Economics at the University of Illinois conducted a study to determine the causes of variation in retail sales between cities. Mr. Ferber hypothesized that factors influencing variations in retail sales to individual consumers are not likely to be the same as those which influence variations in retail sales between cities. His objective was to identify factors influencing variations in retail sales (food, general merchandise, apparel, etc.) between Illinois cities and to measure the relative importance of each in affecting total gross sales. The multivariate correlation statistical technique (multiple linear correlation) was used because it permitted identification of several pertinent variables at a time and also leads to a more precise estimate of the influence of any one variable by extracting its net influence from the interacting effects of other variables. The procedure was to advance a hypothesis regarding the factors that were thought to influence the

variable in question; translate these factors into corresponding variables; and then test by correlation analysis the effect, if any, of each of these variables on the dependent variable (gross sales). The results of this study provided a multiple coefficient of determination (R^2) of .92 (.85 excluding Chicago), referring to the selected factors' ability to explain 92 percent of the variation in gross retail sales between cities. However, even .92 was smaller than the .95 derived while analyzing variations between individual consumers. Almost 92 percent of the variation in total retail sales was explained by the two variables of population and distance between cities. Computation of standardized regression coefficients revealed that population was by far the more important, having an influence on sales more than eight times as large as distance. Mr. Ferber then decided to eliminate the population factor which tended to conceal the presence of other significant variables. This was accomplished by dividing the dependent variable by population to derive per capita gross retail food sales. After this adjustment, results obtained indicated the following: a) contrary to the previous findings, income turned out to be highly significant in most instances (regression coefficient at .6 to .7), b) a high intercorrelation between income distribution and income per capita was discovered and thus it was decided to use only income per capita, c) distance remained an important variable, however, the magnitude of its effect on sales was

no longer high, and d) the number of retail stores in the city was an important determinant on per capita sales. These findings point to income, distance, and number of stores relative to population as major determining factors in the inter-city variation in per capita sales. Specifically with regard to retail food sales, the regression coefficients were as follows: $Y = 1.3^{**} + 0.0X_1 + .23 X_2 + .4X_3$ with a multiple correlation coefficient of determination (R^2) of .21 where:

- Y = Per Capita Retail Food Sales (\$)
- X_1 = Distance (Mi.)
- X_2 = Per Capita Disposable Income (\$)
- X_3 = Number of Retail Food Stores
- * = Statistically significant at .1 level of probability
- ** = Statistically significant at .05 level of probability

In his conclusion, Ferber states, "The evidence is therefore, fairly clear that the forces influencing inter-city variations in per capita sales differ greatly, and that a more or less individualistic approach is needed in each case."¹

Ferber's study is applicable to this paper in the following areas:

1) Ferber recognized that an analysis must be conducted of areas larger than portions of a given city. Ferber analyzed variations between cities, whereas, this paper carries it one step further by studying variations between counties and metropolitan areas.

¹Robert Ferber, "Variations in Retail Sales Between Cities," Bureau of Economic and Business Research, Department of Economics, University of Illinois, Journal of Marketing, Jan. 1958.

2) His objective was similar to one of the objectives of this paper. Mr. Ferber also used a statistical test similar to the one used in this paper.

3) Ferber's results showed a lower R^2 (explaining variations in total gross sales) between cities (.92) than between individual consumers (.95). From this relationship we might likewise expect a lower R^2 for metropolitan areas than counties and for counties than cities. As shown later in this paper, results from this study show this to be true.

4) While analyzing Michigan's data, I also found population to be such a great sales determinant that it had to be eliminated to reveal the significance of other variables.

5) Factors of per capita income and number of stores were also found to be significant in this inter-county study. The importance of the distance factor was shown by Ferber to be of decreasing importance when moving from intra to inter-city analysis. Assuming this trend continued, as the size of the area under analysis increased, distance was not considered to be an important factor in this inter-county study and such data were not even included in the trial runs. Ferber's equation, pertaining specifically to retail food sales, tends to justify this decision.

6) Statements in Ferber's conclusion that areas differ so greatly in their characteristics that an individual approach is needed in each case, seems to agree with the second sub-hypothesis of this paper.

Additional Determinants

In 1962 Mr. N. Osborn Walker conducted a study in the Chicago-Gary, Indiana area for the Jewel Tea Co. The objective of this study was to determine the facilities which will have to be added by the retail food industry to meet the market's requirements in 1990. Since the Jewel Tea Co. bases the dollar volume of their retail food sales on the growth of the population and the ability of the population to buy (income), the process was simply one of projecting these two factors into the year 1990. However, projections of income per capita were complicated by a strong increasing trend in the number of non-white residents of the area producing a downward effect on income levels. In other words, it was discovered that this trend toward a higher ratio of non-whites to whites, while increasing the number of people, will increase the food store potential at a slower rate. In the summary it was stated, "This study indicates that over the thirty year span from 1960 to 1990, the population of this area (Chicago-Gary) will increase 52 percent and that the food store potential gross sales will increase 49 percent. The 4 percent difference is due to the increasing ratio of non-white population with its lower buying power."¹

¹N. Osborne Walker. "A Study of Retail Food Store Facilities Which Will Need to be Constructed in Addition to 1960 Facilities, From 1960 to 1990 in the Chicago-Northwest Indiana Standard Consolidated Area Resulting from the Projected Increase in Population and the Changes in the Ratios of Non-White and White Segments in Certain Divisions of the Area." Jewel Tea Co., Inc., May 28, 1962.

Osborne's study has made the following two contributions to this paper:

- 1) The fact that this study was made for a large retail food organization, illustrates that the industry is indeed anxious to obtain such long run projections. Also, the interest in what facilities will be needed strongly signifies that such projections will actually be used in decisions concerning future expansion plans.
- 2) It suggests that the percent non-white population is another factor worth considering in the projections of retail food sales volume.

Present Location Criteria

In January of 1960, an article appeared in the Chain Store Age magazine entitled "Chains Reveal Rules of Thumb for Choosing Store Locations." This article emphasizes the fact that a large portion of the retail food industry still uses "rule of thumb" considerations rather than empirical studies to select locations of new outlets. Below are listed some of the "rule of thumb" considerations used in choosing future food store locations, as submitted by a group of large chain store organizations.¹

- Does the location now have the needed population within a limited area?

¹"Chains Reveal Rules of Thumb for Choosing Store Locations," Chain Store Age, Jan. 1960, pp. E33-E38.

- Are the road patterns or access routes adequate?
- Competition?
- Are anchor tenants being placed on the property to induce the greatest amount of traffic flow?
- Current volume of retail outlets in the area?
- Total number of existing square feet of food store space in the area?

It can easily be seen that no reference is made to what this area's characteristics might be like in the future. No interest was expressed about the location's potential sales volume. All of the rule of thumb considerations certainly do contribute to the success or failure of a retail food outlet, however, there is a sincere need for additional inquiries into the area's overall potential.

Views of Outside Interests

The retail food industry is not the only agency that should be interested in more accurate forecasts as to the success or failure of a proposed outlet. A great deal of outside financing often is necessary before a new outlet can be located and built. Thus lending agencies are looking for accurate information which might make their investments less risky. James W. Rouse, a mortgage banker in Baltimore, states that banker's in their role of financing a number of retail food outlets, have spent a great deal of time attempting to devise a method that would yield valid estimates of

the success or failure of a given outlet.

In Mr. Rouse's opinion, there are a number of weaknesses inherent in the previously used judgment approach. First of all, there is no such thing as a finite trading area in an urban community. Secondly, the complex interplay of competing retail food areas within a large urban area is beyond accurate evaluation based on judgments, alone. Thirdly, there seems to be evident in most such judgment-surveys an unintentionally optimistic bias in estimating amounts of purchases to be made at a new outlet. Often the end result of these errors produces stores that are uneconomic for their owners, tenants, and investors.¹

This article by Mr. Rouse serves only to re-emphasize that the retail food industry, both in Michigan and the nation, is in need of a valid statistical technique by which potential retail food sales volume can be projected in the future.

Along with financiers, realtors are also interested in the market potential of an area so that they might be able to more accurately appraise the true value of possible food store locations.

An article in the Appraisal Journal written by Leow W. Ellwood, illustrates their attempts to better visualize this problem. The following statements are typical of those characterizing the realtors' views towards estimating potential sales volume.

¹James W. Rouse. "Estimating Productivity for Planned Regional Shopping Centers," Urban Land, Oct. 1953, pp. 1-5.

- An estimate of potential volume for a proposed new food store must start with information as to the existing volume of business.
- An estimate of the potential volume of a proposed new food store must allow for the composite pull of all other competing retail districts.
- Since most shopping expeditions start from home, the optimum size of each retail outlet is usually governed by the number of homes to which it is more accessible than all other competitive retail districts.

Mr. Ellwoods concludes by saying that the problem of estimating the potential volume of a proposed new shopping center is one in which prime factors are: a) existing volume of trade, b) existing shopping facilities and c) accessibility of the proposed location to the population of the trade areas.¹

This study seems quite applicable to this paper since data on existing volume of retail food trade and number of existing retail food facilities were used as dependent and independent variables, respectively, in the multiple linear regression equations used in my statistical computations. Even though Ellwood's work deals with one particular shopping area there is no reason to think this would not apply to an entire market such as an entire county. However, accessibility

¹Leon W. Ellwood. "Estimating Potential Volume of Proposed Shopping Centers," The Appraisal Journal, Oct. 1954, pp. 581-587.

(distance) has previously been shown (Ferber's study) to have only limited significance when dealing with areas as large as counties.

Population and Reilly's Law

As early as 1949, people, such as Edna Douglas at Iowa State University, were interested in retail food sales potential estimation. Miss Douglas conducted a cross sectional analysis of a retail area by determining the location of the banks against which were drawn checks deposited in a local bank by a group of local retail outlets. Despite many problems arising, i.e., some local people had checking accounts in a far distant town, and a tendency not to reveal accurately the comparative intensity of sales distribution between nearby and more distant communities, she was able to assert this conclusion: "One can conclude, therefore, that population density is less useful as a means of delineating trading areas than as a means of explaining why out of town customers are more plentiful from certain localities than from others and of providing a basis for measuring intensity of drawing power."¹ It was this statement that suggested consideration of population density as one of the possible significant determinant factors.

¹Edna Douglas. "Measuring the General Retail Food Trading Area - A Case Study: II", Journal of Marketing, July 1949, 14:46-60.

Miss Douglas also recognized such non-price factors as quality and quantity of merchandise; terms of sale, including such things as the return goods privilege, credit, certain services, guarantees, etc.; and selling methods, as well as buying habits and knowledge of the market situation to be determinant factors. She then rectifies this phenomena by stating that the size of retail area has been proven an adequate indirect measure of these non-price factors in retail selling.

As previously mentioned, market analysis on a strictly local basis has become highly developed. For example, once the decision has been made to construct a new retail food store in a given city or town, the process of analyzing this local market for the optimal store site has become fairly routine, thanks to the contributions of William J. Reilly. Back in the early 1930's, Mr. Reilly began conducting inquiries in various Texas cities to determine a mathematical equation which might accurately describe the retail pulling power between two retail markets. From his work, Reilly developed his "Law of Retail Gravitation" which states:

"Two local markets attract trade from a third market in the vicinity of the breaking point approximately in direct proportion to the population of two markets and in iverse proportion to the squares of the distance from these two markets to the third market."

OR

$$\frac{E_a}{E_b} = \frac{P_a}{P_b} \cdot \frac{D_b^2}{D_a^2}$$

Where: B_a = proportion of the trade from the third market attracted by market A

B_b = proportion attracted by market B

P_a = population of market A

P_b = population of market B

D_a = distance from third market to market A

D_b = distance from third market to market B¹

Through the use of this formula, retailers could look at a city, measure population and distances between trading areas, and thereby accurately determine the area in which the drawing power of a proposed store would have an effect.

Other men like P. D. Converse at the University of Illinois immediately became interested in the validity of Reilly's Law and conducted further studies. Converse found that the law remained accurate only when considering a small trading area. As the distance between markets approached twenty or more miles, the formula became less valid, due to the over-emphasis of the population factor. Thus, when analyzing trade areas as large as a county, Converse suggested substituting an inertia factor for D_b in the formula:²

$$\frac{B_a}{B_b} = \frac{P_a}{P_b} \frac{X}{D_a}^2$$

¹William J. Reilly. The Law of Retail Gravitation. New York: William J. Reilly, 1931.

²P. D. Converse. "New Laws of Retail Gravitation," Journal of Marketing, Oct. 1949, 14:379-84.

Where: X = inertia factor of whatever magnitude it takes to make the formula valid.

The major deficiency in this approach recognized by Converse was the fact that inertia factors were highly subjective and varied in magnitude not only among various distances, but also between markets. Thus, this leaves no definite pattern proven applicable to market areas in general. This also seems to be the opinion of R. B. Reynolds following some Iowa tests.¹

As might be expected, results of tests like those of Ferber's, have shown population to be a major factor in determining potential gross retail food sales. Likewise, population is most important in other areas of our economy. Despite this phenomena, it seems extremely alarming to this author that economists have in the past tended to dismiss their acknowledgement of our nation's population trends by passing on these problems to demographers. The prominent economist, Milton Friedman, admits to this occurrence by saying, "Population, it was said, depends primarily on a host of non-economic considerations which are not within our (economists) competence or field of interest. Only recently, have economists renewed their interest in population theory and have become again concerned with reintegrating the theory of population with economic theory - a development that is to

¹R. B. Reynolds. "A Test of the Laws of Retail Gravitation," Journal of Marketing, Jan. 1953, 17:273-77.

be encouraged."¹ Less justification than this is needed to approve the use of the population factor in this study.

Income and Engel's Law

Income levels, however, unlike population have always been maintained as an integral part in economic writings. Since much literature is available on income's effect on consumer's expenditures on food, I shall attempt to only mention writings of particular interest to this paper.

Income effect on the habits of individual consumer's actions at the market can best be illustrated in these statements:

- First, low income housewives have a slightly greater tendency than those with higher incomes to respond to a hypothetical general food price level change and a corresponding hypothetical income change as though they are synonymous.
- Second, the consumer with a higher income has a greater tendency than those with lower incomes to follow habit patterns in purchasing food.²

A true economist dare not discuss income's effect on food purchases without recognizing Engel's law. In 1857,

¹Milton Friedman, Price Theory, University of Chicago, 1962, p. 208.

²Warren J. Bilkey, The Basic Relationships in Consumer Expenditure Behavior, Harvard Studies in Marketing Farm Products, Cambridge, Mass., Number 4-H, Oct. 1951, pp. 33-45.

Ernst Engel studied the expenditures of families of all levels of income in Belgium and Saxony. His data showed a consistently higher percentage of total expenditures going for food coincident with lower average incomes per family. He concluded, "The poorer a family, the greater the proportion of total outgo that must be used for food."¹ It is to be noted that Engel's analysis was confined to one period in time. Because of this, many economists have tended to discount the validity of Engel's law when attempting to apply it to a dynamic situation. Marguerite C. Burk attempted to test the validity of Engel's Law in a static vs. dynamic situation and arrived at the conclusion that Engel's Law probably applies reasonably well to all the relationships of average income and food expenditures through periods in which no substantial changes take place in population patterns, distribution of income, manner of living, and marketing practices. That is to say, it applies under conditions that are relatively static....²

Marguerite C. Burk's study is extremely relevant to this paper since both static (cross-sectional) and dynamic (time series) analysis are conducted on income and food

¹Translated from page 26 - DIE LEBENSKOSTEN BELGISCHER ARBEITER - FAMILIEN FRÜHER UND JETZT - ERMITTELT AUS FAMILIEN - HAUSHALTSRECHNUNGEN., Inst. Internatl. Statistical Bulletin 9: 1-124, III, 1895.

²Marguerite C. Burk. "A Study of Recent Relationships Between Income and Food Expenditures," U.S.D.A., Agriculture Economic Research III, No. 3, July 1951.

expenditures data. This will make possible the testing of the existence and validity of Engel's Law within the state of Michigan under both static and dynamic conditions.

Marguerite C. Burk has written many other articles on income-food relationships. Major findings of these articles may be summarized as follows:

- 1) The effect of real income on quantity of food consumed has changed only slightly in the last 20 years.
- 2) The level of use of food market services has risen significantly with much of the change occurring in 1939-41 and 1945-47.
- 3) This change in level of food market services resulted in higher postwar levels of market value of all food consumed and therefore, of dollar value food expenditures in relation to income elasticities for the food value measures.
- 4) Analysis of survey data shows that major increases in the demand for commercially produced food and for food marketing services in relation to income have come primarily among farm and rural non-farm households and lower income urban households.
- 5) Increases in average consumption of food from all sources resulted from higher incomes whereas the use of food marketing services has exceeded expectations based on income-market service relationships in prewar years.¹

¹Marguerite C. Burk. "Some Analysis of Income-Food Relationships," Journal of the American Statistical Association, 53:284, Dec. 1958, pp. 905-927.

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Another study, testing the sensitivity of expenditure to income changes used as a coefficient the average percent change in expenditure per one percent change in disposable per capita income, holding constant the effect of trend.

The results are as follows:

Expenditure	Sensitivity Coefficient
I. Total consumption expenditures	.86
II. Durable goods	
boats and pleasure aircraft	3.19
radios, phonographs	2.59
new automobiles	2.00
(of 22 durable goods groups, only 2 showed coefficients which are less than 1.0 and for the majority of them, the sensitivity measure was 1.40 or higher)	
III. Non-durable goods	
food purchased for on premise dining	1.69
food purchased for off premise consumption	.95
shoes	.69
IV. Services	
bus fares	.79
automobile insurance payments	.69
telephone	.49
gasoline	.29
electricity	.29

In general, therefore, the durable goods were found to be above average in sensitivity, the non-durables - average, and the services - below average.¹

¹Clement Winston and Mabel A. Smith. "Income Sensitivity of Consumption Expenditure," Survey of Current Business, January 1950, pp. 17-20.

Tourist Effect

Before proceeding into Chapter III and a more detailed inquiry of possible determinant variables, a short discussion is necessary concerning a characteristic of Michigan which is different from that of the average state. This characteristic requires that certain adjustments be made when analyzing the northern portion of this state. The northern one-half of Michigan is characterized by a large influx of summer tourists. The small resident population (relative to the annual tourist population) of this area only tends to add to the inaccuracy of food sales data as it applies to a given county. For example, the data on "annual gross retail food sales per person"* will be an overestimate of the true value. This occurs because total gross retail food sales data includes purchases made by the transient population, whereas population data include only permanent residents of the area. Thus, to render these data more accurate, they should be deflated by a "tourist index" - which with existing information is relatively unmeasurable.

Accurate marketing appraisal is statistically difficult in northern Michigan since the tourist patterns are geographically and functionally mingled with the resident populace.

* $\left(\frac{\text{Total Annual Retail Food Sales}_{tj}}{\text{Total Population}_{tj}} \right) = \text{Annual retail Food Sales per Person}_{tj}$
 $t = \text{time, years } (i) = 1951-62, j = \text{counties } (1-83).$

The yearly buying power of a floating population is in many respects different from that of the resident populace. For instance, the vacationers in a tourist area usually spend more than the resident on the same level of income and his spending goes into different items of consumption.

In general, one may assume that annual tourist days, multiplied by mean daily spending will yield the figure of aggregate buying power of the floating population. However, in many areas the mean spending is likely to be subject to large seasonal fluctuations. Since the data used in this paper is all of an annual nature, seasonal fluctuations will not be evident.

Also the consumption of the floating population, especially travelers, is different from that of the resident or permanent population. With respect to retail food sales for instance, it is understandable that a tourist group is likely to buy less food in grocery stores but spend more in restaurants than the resident population.¹

A recent study done in Michigan by the Bureau of Business and Economic Research of Michigan State University produced the following data which aid in describing the extent of tourism in Michigan.

Even though the number of tourists visiting the upper peninsula is not the largest of any state area, the effect of

¹Reinhold, P. Wolff. "Estimating the Market Potential of a Floating Population," Journal of Marketing, July 1954, 19:12-17.

Table 5. Proportion of Tourists Who Visited Each State Area¹

(% of Respondents)					
Destination of Tourists	15	25	35	45	55
Upper Pen.					
Western					
Eastern					
Detroit					

Estimated total food purchases by tourists in the
upper peninsula

1962 \$32,348,475.00²

tourism is much greater because of the extremely small
resident population, relative to the other three state areas.

Table 6 illustrates that those tourists visiting the
northern portion of the state tend to spend more money and
thereby increase their effects.

¹Michigan Tourist Survey 1957, Bureau of Business and
Economic Research, Michigan State Univ., p. 29.

²"Tourism Trends," The Michigan Economic Record, Vol.
6, No. 2, Bureau of Business and Economic Research, Michigan
State Univ., Feb. 1964.

Table 6. Tourist's Expenditure by Areas Visited.¹

<u>Area</u>	<u>Median Expenditure</u>
<u>Upper Pen.</u>	<u>\$179.08 (before the Mackinac bridge)</u>
<u>Western</u>	<u>176.79</u>
<u>Eastern</u>	<u>155.72</u>
<u>Detroit</u>	<u>136.12</u>

¹Michigan Tourist Survey 1957.

CHAPTER III

JUSTIFICATION AND EXPLANATION OF POSSIBLE SIGNIFICANT VARIABLES

DEPENDENT VARIABLE:

Throughout all the statistical analysis, gross retail food sales data is used as the dependent variable. The first portion of statistical analysis represents an attempt to determine which factors are significant determinants of the volume of gross retail food sales. The time series study will determine the importance of these selected factors in explaining variations in gross retail food sales by country over the twelve consecutive years. The cross-sectional study will determine the importance of these factors in explaining variations by year among counties.

In the final analysis and projection, the estimated potential retail food sales for the state and counties are calculated. It is hoped that the technique used in this paper will prove reliable enough so that the estimates may be used, with confidence, by the Michigan retail food industry in their plans for future expansion and new store locations. Since these estimates will be mostly on a county basis, they can suggest only the general areas of the state having increasing (or decreasing) opportunities and normally cannot be used in the market analysis of an area as small as a city. An exception to this would be in cities such as Detroit or Lansing where a large portion of a county's buying power is

located within the city. Even though all gross sales data is in the form of dollar volume, it is assumed that the industry will be able to convert this dollar value into data referring to the additional store facilities that will be required in the future to adequately handle this increased (or decreased) demand for food products.

INDEPENDENT VARIABLES:

A large number of factors have been mentioned as effecting the food sales of an area. It would be virtually impossible to discuss each factor mentioned as a possible food sales determinant. Instead, only those factors found to be significant in other studies of this nature will be discussed. Following the accumulation of Michigan data on these variables, numerous trial runs were conducted. By the use of regression analysis, it was determined which of the independent variables were significant in Michigan and which to eliminate.

Population: As was so clearly illustrated in Ferber's study, population is of the greatest importance in determining the gross food sales volume of a given area. Its importance is well expressed in the statement, "The wonderful thing about food from our point of view is that everybody uses it - and uses it only once."¹ This food retailer's statement illustrates the unique type of built-in obsolescence that food

¹"Food That Isn't Food," Life Magazine, June 2, 1961, p. 9.

products possess. Its utility is not of a long lasting nature, and once consumed, can never be done so again. As unique as this quality may seem, it serves to partially explain why population is so closely related to retail food sales.

Americans consume about 1500 lbs. of food per capita per annum, which reportedly has varied little in amount over a considerable span of years.¹ Food, unlike some other consumer products, is an absolute requirement for human existence; hence the selling job for the generic product is not an overly difficult one. Moreover, food is needed not just once in a while, as is the case of most commodities, but at frequent and regular intervals. One of the characteristics of food items, therefore, is that they are procured on a repeat-purchase basis.²

Thus, the relationship between food sales and population, alone, is partially physical rather than economic. The relationship is direct and positive in nature, indicating that an increase in the population will, out of physical necessity, produce increased food sales.

¹"Concentration and Integration in Retailing," Staff Report to the Federal Trade Commission - Economic Inquiry into Food Marketing, Part I, Govt. Printing Office, Washington, D.C., Jan. 1962, p. 32.

²Cassidy, p. 3.

Even within the general population criteria other characteristics such as distribution, percent non-white, etc. are found to have an effect on food sales. For example, changes in population composition and family size have been shown to have an effect on the income elasticity and demand for food.¹ In a study by Robert Herrman, it was shown how the per family income elasticity for the demand for food increased from .68 to .92 as the size of family increased from 2 to 6 people. In forecasting the demand for food, Herrman suggested that one should recognize that larger families are more responsive to income changes than a smaller family. Other population characteristics such as education level, ethnic background, religion, etc. were found to produce no significant differences in food expenditures per capita when income and family size were controlled.²

Percent Non-White Population: Walker's study of the Chicago-Gray market area revealed the importance of another phase of population composition. In this study, the increasing percent

¹Robert Omer Herrman. "An Investigation of Differences in Income Elasticities of Demand for Food in Households of Differing Size and Composition," Michigan State University, 1961, p. 63.

²Thomas Neil Moss. "Some Relationships of Selected Socio-Economic Factors to Food Consumption and Expenditures," Michigan State University, 1952, pp. 140-41.

non-white population was found to exert a downward influence on potential gross retail food sales of the area. Other available information¹ on the effects of race on food expenditures seems to indicate that the influence of this factor may be declining. What differences do exist, between white and non-white consumption behavior, tend to disappear as the income level of the non-white is increased.² Negro families were found to save more at the same level of current income than did white families and Negro households were larger than the white households in most cases. Average expenditure for food was found to be generally larger in white than in Negro households at a given income level, the difference being greatest at lower income levels.³

No extensive information on non-white buying habits in the state of Michigan could be found. However, some basic assumptions can be made:

- 1) Difference in non-white food purchasing behavior can be largely attributed to income levels, rather than tests or

¹Willard W. Cochrane, and Carolyn S. Bell. The Economics of Consumption, New York: McGraw Hill, 1956, pp. 199-201.

²U.S. Department of Agriculture, Food Consumption of Households in the U.S., Report No. 1; Washington, U.S. Printing Office, 1956, p. 190.

³University of Pennsylvania, Study of Consumer Expenditures, Incomes and Savings, Vol. III, tabulated by the Bureau of Labor Statistics for the Wharton School of Finance and Commerce, 1956, pp. 138-140.

preference disparity, and

2) Regardless of the attributing factor, a trend toward a higher percent non-white population will have a deflationary effect on an area's potential retail food sales, with this effect decreasing over time as non-white's incomes rise.

Rural-Urban Population Distribution: Another factor highly related to population composition is the rural-urban distribution. Michigan county population varies from being 100 percent rural in the northern counties such as Missaukee and Baraga to over 90 percent urban as in Wayne county. Due to this heavy concentration of this state's population in the southern most counties, it may be described as an urbanized state with slightly less than 75 percent of the state's total population living in urban areas in 1960.

Food consumption of rural residents has been found to differ from that of urban dwellers for various reasons. First, the rural family will tend to eat a larger quantity of food as well as more high calorie foods. This is attributed to the greater amount of physical exertion required in the daily routine of the rural resident, compared to the urbanite. Secondly, the rural family will eat a larger proportion of home-grown foods. A lower proportion of a family's total food consumption is purchased at a store and this might cause retail food sales data to be an underestimate of true consumption. Thirdly, income level is also interrelated to this

factor, in that rural residents generally have a lower annual income level, thereby inducing them to buy more of the lower priced food products.

Generally speaking, then, one could say that a steady decline in the percent rural residents, as Michigan has experienced in recent years, would have an inflationary effect on future potential food sales in an area. This trend is not only characteristic of the state of Michigan, but of the whole nation.

Population Density: The last population characteristic, to be considered as a possible food sales determinant, is population density. The word density refers to the inhabitants per square mile. Population density can be considered an indirect measure of the distance factor mentioned in Ferber's study. For example, when analyzing a county such as Wayne, one finds a population density of 4,392 persons per square mile, (1960) This indicates that on the average, a new food outlet would have a population of over 4,000 within a one-half mile radius. The factor of distance would then be of little importance since a large portion of the store's customers will live within walking distance of the store. However, now looking at the population density of a county like Keweenaw is only 4.4 persons per square mile. Here a store's mere existence may depend on the whole county's population, who may have to travel twenty miles or more just to reach the store.

A complicating factor in this analysis is the recent construction of huge shopping centers. Traditionally, firms choose locations on a basis of independently made decisions, but some firms now prefer to locate along with other non-competing stores in a shopping center, thus obtaining the advantage resulting from the drawing power of several merchandising institutions rather than just one. It appears that the attraction of any individual store within a shopping area is enhanced by the fact that other stores providing a range of different products or services surround it. Thus, it is often postulated that in the case of a shopping center or retail cluster the combination of stores possesses an attraction to the customer that is greater than any of the stores, taken individually and thereby exerts an additional influence to that of an area's population density.¹

Food Store Numbers (and size): The next factor to be considered is the number of retail food outlets in a given area. Food store numbers considered an indirect measure of market concentration, saturation, and competition. Bernard LaLonde conducted a Michigan study to determine the importance of store size or store complex on per shopper sales.² Store complex was considered to be the number of outlets in the

¹Cassidy, p. 89.

²Bernard Joseph LaLonde. "Differential in Supermarket Drawing Power and Per Capita Sales by Store Complex and Store Size," Michigan State University, 1961, p. 119.

local market area studied. Store size was measured by the number of products offered for sale per store. Results of LaLonde's study indicated:

- 1) Store complex was an important influence in determining the drawing power and per shopper sales of the food stores,
- 2) store size was not an important variable in determining per shopper sales, and
- 3) there existed distinct and significant patterns of per shopper sales which could be isolated and quantitatively analyzed as a basis for future location discussion.

Some additional conclusions were:

- 1) As the product offering increased, drawing power increased, but per shopper sales decreased,
- 2) influence of store complex on per shopper sales became greater as the distance from the survey store increased, and
- 3) there was no systematic and reliable connection between store size and per shopper sales from which any economic discussion could be based.¹

Market concentration can be measured in one of the following three ways:

- 1) Volume of sales accounted for by various numbers of stores,
- 2) number of persons served per store, or
- 3) number of stores.

¹LaLonde, pp. 139-40.

Market concentration becomes quite important when the industry is evaluating an area (city, counties, or state) for future expansion.

In addition to size of the area, population growth affects the degree of concentration. Rapidly growing areas attract new entrants and hence make it more difficult for existing firms to expand their share of the market. There is a tendency for sales concentration in the retail food industry to be highest in the smaller markets. This reflects the fact that chains which are relatively unimportant nationally, often are very important in their local markets.¹

While the quantity of grocery items available at retail food locations at any one time normally is of little significance, the number of food stores is a significant factor which can often have a severe effect on both price and non-price competition. Relative fewness encourages concerted behavior, even in the absence of collusion, with the result that such industries behave less competitively than when numbers are larger.

Income Level: The relationship between income and food expenditure has been expressed by economists both in the form of income-expenditure elasticities of demand for food and as Engel curves representing food expenditures at various levels of income.

¹Mueller and Garoian, p. 33.

Income-expenditure elasticity is defined as the ratio of the percentage change in expenditure to the percentage change in income and is expressed mathematically as:¹

$$\frac{\partial Y}{\partial X} \cdot \frac{X}{Y}$$

Where: Y = food expenditure
X = income

The Engel curve for total food expenditure is related to the above since the slope of the Engel curve, $\frac{\partial Y}{\partial X}$, is part of the mathematical expression of income elasticity, however, it must be remembered that the original law applied to a static condition and not to changes in income levels over time.

People like Robert Ferber, Marguerite C. Burk and George R. Rockwell have long been presenting empirical proof of the relationship between income and food expenditures. Ferber found the relationship to exist only after the interacting influence of other variables (population) had been removed.² Likewise, Marguerite C. Burk made some important discoveries about the changes in the income elasticity of demand for food over the past few years. The following diagram will best describe this change.

¹Wold, Herman, and Jureen Lars. Demand Analysis, (New York: John Wiley and Sons, 1953) p. 98.

²Ferber, p. 303.

Figure 1

Average Food Expenditure and Disposable Income Per Capita

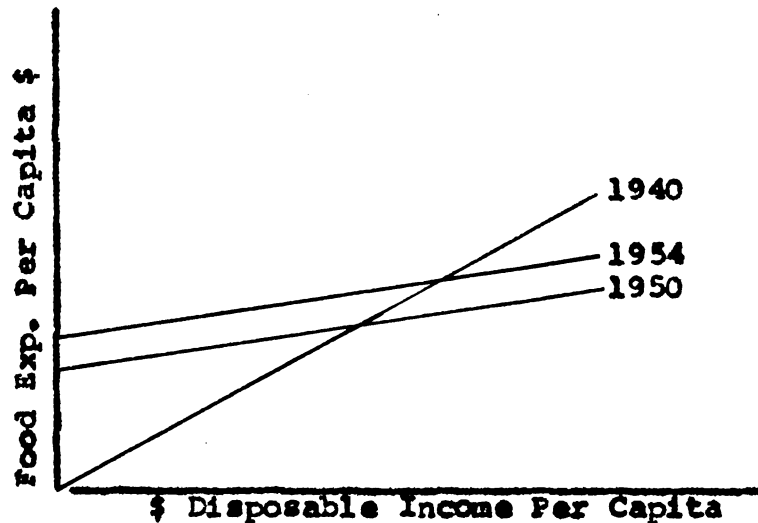


Figure 1 illustrates that during the period of 1940-50 the line became more elastic, however, beginning in the 1950's the whole line began to shift upwards due to increased use of prepared foods of higher costs. At a given income, changes beginning in the 1950's would indicate a trend towards a slightly more inelastic income demand for food products.¹

George R. Rockwell contributed to this general discussion by stating, "The percentage change in consumption per person in relation to the percentage change in income per person, or income elasticity, is considerably different for various kinds of food. There are also wide variations in the income elasticities in low-, medium-, and high-income households."²

¹Burk, p. 89.

²George R. Rockwell, Jr. Income and Household Size: Their Effects on Food Consumption, Market Research Division, U.S.D.A., Report No. 340, Feb. 1961, p. iv.

In general, one may say that rising incomes have a positive effect on gross retail food sales, the extent of which varies greatly between areas and type of food purchased.

Price Level: Assuming the reader has the economic knowledge of the basic product price-demand relationship, little explanation is necessary to describe this relationship between the food pricelevel and food purchases. For purposes of this study, consumer food prices are assumed to be constant for all counties during time periods of less than one year. Price changes over periods of one year or longer will be taken into account by the use of a food price index discussed later.

ACCUMULATION OF DATA:

Gross Retail Food Sales - raw data on the dollar volume of annual retail food sales is not published either by county or metropolitan area. However, the state of Michigan levies a 4 percent sales tax on all items sold in food stores¹ and this information (tax receipts data) is published by county

¹There is hereby levied upon and there shall be collected from all persons engaged in the business of making sales at retail, as hereinbefore defined, an annual tax for the privilege of engaging in such business equal to 4% of the gross proceeds thereof, plus the penalty and interest when applicable as hereinafter provided, less deductions allowed in sections 4 and 4a". - first paragraph of Section 2, of the Michigan Sales Tax Act, Act 167, P.A. 1933, as amended.

in the Annual Report-Michigan Department of Revenue.

Sales tax data was collected from this report for the years 1951-52 and converted into gross retail food sales by the following computations:

$$1951-60: (X + 3) \cdot 100 = Z$$

$$1961: \left[\frac{(X \cdot 60.45\%)}{3} \right] \cdot 100 + \left[\frac{(X \cdot 39.52\%)}{4} \right] \cdot 100 = Z^1$$

$$1962: (X + 4) \cdot 100 = Z$$

Where: X = total retail food sales tax
Z = total gross retail food taxable sales

Approximately ten percent of the food store sales are non-food items. This would indicate that the derived data is not a truly accurate indication of food sales. However, Mr. W.A. Wharton² stated that approximately ten percent of total food sales were not included in the food sales tax data because these products were sold from places other than those classified as food stores, i.e., gas stations, drug stores, department stores, etc. The ten percent loss and ten percent misallocation then tend to offset each other, leaving the derived data "moderately accurate."³ Gross retail food sales

¹Prior to Jan. 1, 1961 the sales tax law read "3%". During 1961, often called the "dirty year" by tax analysts, 60.45% of annual food sales were taxed at 3% and the remainder at 4%.

²Research Director of the Michigan Department of Revenue.

³Considered by W.A. Wharton to be $\pm$ 2% of true food sales for a given area.

data was thereby accumulated for the state of Michigan and its 83 counties for the twelve year period of 1951-62.

Table 7. Annual Gross Retail Food Sales for Selected Counties and State*.

	(\$000)					
	Baragua	Missaukee	Barrien	Ingham	Wayne	State
1951	1,805	895	47,337	66,378	1030,466	2573,817
1953	1,937	1,114	53,966	76,776	1160,301	2703,323
1955	1,861	1,194	54,501	79,201	1168,600	2558,462
1958	2,204	1,595	63,109	91,939	1151,002	3264,400
1960	2,307	1,563	69,118	95,163	1021,462	3357,008
1962	2,506	1,338	68,178	93,239	1016,891	3357,208

Population - population data for the state of Michigan and its 83 counties are available in the U.S. Census of Michigan Population, however, this data is only published at the beginning of every decade 1940, 1950, 1960, etc. Data for the inter-census years was obtained from Sales Management's "Annual Survey of Buying Power," published in July of each year.

As shown in table 8, Michigan's population has been increasing at approximately 2.23 percent per year, considerably above the average increase of 1.83 percent recorded for the nation as a whole.

*Data derived from sales tax data - information for remaining 73 counties can be found in Appendix A.

Table 8. Population for Selected Counties and State*.

	Sarasota	Missaukee	(000) Berrien	Ingham	Wayne	State
1951	7,943	7,391	119.1	176.9	2458.3	6516.9
1953	7,777	7,256	126.0	184.4	2504.5	6809.2
1955	7,594	7,121	132.8	192.1	2550.8	7097.5
1958	7,323	6,919	143.0	203.6	2620.1	7532.9
1960	7,151	6,784	149.9	211.3	2666.3	7823.2
1962	6,934	6,661	158.8	220.8	2717.2	8205.9

Percent Non-White Population - slightly less than ten percent of Michigan's population is non-white. This proportion has been growing steadily at about .22 percent per year. Over one-half of the non-white population in the northern most part of the state consists of Indians, while Negroes are prominent in the south's non-white population. Moving from north to south and from west to east, the percent non-white population increases.

Table 9 illustrates how the percent non-white population is increasing in the southern counties while it is decreasing in some of the northern ones.

Population Density - generally speaking, population density is decreasing in the northern counties of Michigan and increasing in the southern counties.

*Additional information in Appendix A.

Table 9. Proportion Non-White Population.

(Percent of Total)						
	Baraga	Missaukee	Berrien	Ingham	Wayne	State
1951	5.76	.57	6.45	2.19	14.52	7.33
1953	5.28	.51	6.95	2.57	15.76	7.79
1955	4.80	.45	7.45	2.95	17.00	8.25
1958	4.08	.36	8.20	3.52	18.86	8.94
1960	3.60	.30	8.70	3.90	20.10	9.40
1962	3.12	.24	9.13	4.07	21.19	9.80

Table 10. Population Density.

(Persons/Square Mile)						
	Baraga	Missaukee	Berrien	Ingham	Wayne	State
1951	8.80	13.08	205.39	316.26	4049.97	114.25
1953	8.60	12.84	217.17	329.98	4126.11	119.35
1955	8.40	12.60	228.95	343.70	4202.25	124.45
1958	8.10	12.24	246.62	364.28	4316.46	132.10
1960	7.90	12.00	258.40	378.00	4392.60	137.20
1962	7.70	11.76	270.18	391.72	4468.74	142.30

Rural-Urban Population Distribution - southern Michigan

counties are slowly becoming more urbanized, however, many of the northern counties still have no incorporated village large enough to be considered an urban area.

Table 11. Percent of Total Population - Urban.

	Baraga	Missaukee	Berrien	Ingham	Wayne	State
1951	0	0	50.23	78.68	96.96	70.97
1953	0	0	50.09	79.44	97.08	72.05
1955	0	0	49.95	80.20	97.20	72.05
1958	0	0	49.74	81.34	97.38	72.86
1960	0	0	49.60	82.10	97.50	73.40
1962	0	0	49.46	82.86	97.62	73.94

Number of Food Stores - during the twelve year period of 1951-62, every county in Michigan experienced a decrease in the number of retail food outlets. This information was extracted from the U.S. Business Census. Data for the inter-census years were derived by linear interpolation. It must be noted, however, that a decrease in the number of facilities is often misleading since those outlets remaining have generally increased in size.

Table 12. Number of Retail Food Stores*.

	Baraga	Missaukee	Berrien	Ingham	Wayne	State
1951	18	23	321	351	6495	16531
1953	16	19	299	322	5959	15210
1955	14	18	282	303	5522	14292
1958	14	19	265	291	5010	13529
1960	12	18	247	270	4552	12505
1962	11	17	230	251	4110	11572

*Additional information in Appendix A.

Income Levels - income data was also extracted from the "Annual Survey of Buying Power" published each July by Sales Management. This magazine arrived at these levels by taking a survey of each county using mail questionnaires and personal interviews. I chose per capita disposable income (total earned income less taxes) believing it to be the best indication of funds available for food purchases.

Table 13. Per Capita Disposable Income.

	Baraga	Missaukee	Berrien	Ingham	Wayne	State
1951	1486	938	1517	1799	1408	1610
1953	870	879	1439	1837	113	1641
1955	967	974	1571	2028	1212	1815
1958	113	1154	1635	2026	1322	1810
1960	1202	1251	1838	2374	1434	2224
1962	1232	1182	1963	2140	1512	2000

Now that I have listed, explained, and illustrated those factors which are to be considered as possible determinant variables, I shall present a short description of the statistical tests available to determine which of these factors are significantly important in Michigan. Chapter IV will examine the alternatives available and describe the statistical technique finally chosen.

CHAPTER IV

POSSIBLE STATISTICAL PROCEDURES

Now that consideration, of these variables mentioned in Chapter II, has been justified, statistical tests will be used to determine which of these factors, if any, has a measurable effect on the volume of gross retail food sales at a specific time within the state of Michigan. It must be noted, however, that the selection of a given variable, shown to have a significant effect in Michigan, does not indicate that this same factor will have a similar effect in other areas or under different situations.

In general, statistical analysis involves the testing of a hypothesis, which for purposes of this first procedure shall be: X_1 has no effect on gross retail food sales of a given area. The purpose of the statistical test is to accept or reject the (null) hypothesis, and to do so while minimizing the loss function.¹

$$^1L = \alpha P_1 C_1 + \beta P_2 C_2$$

L = total expected loss

α = probability of Type I error (rejection of null hypothesis when its true)

β = probability of Type II error (acceptance of null hypothesis when its false)

P_1 = prior probability that null hypothesis is true

P_2 = prior probability that null hypothesis is false and alternative true

C_1 = cost of Type I error

C_2 = cost of Type II error

The following section presents a short discussion of the commonly used statistical test procedures.

Chi-Square Test: Probably the simplest technique which is used to determine the dependency between X_1 and gross food sales is the chi-square test. The basic procedure involves testing the dependency between one independent and one dependent variable. This test can be applied when data for both variables are qualitative in nature.¹ Since the data obtained in this study are all quantitative, the use of the chi-square test would be an unnecessary simplification. Just as the chi-square test uses the slightest amount of intricate data and detail in its procedure, likewise, the results are of only the slightest value relative to those of the following two statistical tests. The chi-square test does establish the relationship, if any, between a dependent and independent variable, however, it provides no numerical measurement of this relationship nor does it provide any empirical data from which projections can be made.² Also, analysis of an area as small as a county, would require survey data from various

¹L. V. Manderscheid, "An Introduction to Statistical Testing," Agriculture Economists Mimeo 867 - revised, Feb. 1964, pp. 6-8.

²Frederick E. Croxton and Dudley J. Cowden, Applied General Statistics, Prentice-Hall, Inc., Englewood Cliffs, N.J., April 1956, pp. 681-693.

areas within the county. Thus, the information presently available would only allow for a state analysis, with county data serving as observations within the state.

Analysis of Variances: The hypothesis generally tested in the analysis of variance technique is the equality between the means of several groups of data, each effected by a different degree of influence of an independent variable.¹ An individual county analysis is possible within the scope of this analysis, however, just as is the case with the chi-square test, data from various areas within the county at a given time would be necessary. However, if observations were made over a period of time, this would not be necessary.

The analysis of variance requires that at the least the dependent variable be quantitative in nature. Just as the analysis of variance requires a more detailed procedure than does the chi-square test, it also provides more precise results. Nevertheless, this test also provides no numerical measure of the relationship between variables, nor does it exhibit any basis from which projections could be made.

Regression Analysis: While the first two statistical techniques discussed were useful in the testing of hypothesis,

¹Dixon, Wilfreid J., and Frank J. Massey Jr., Introduction to Statistical Analysis, 2nd Ed. McGraw-Hill Book Company Inc., New York, 1957, pp. 146-152.

they are of extremely limited value when estimating the effects of independent variables on a dependent variable. However, the regression analysis technique is especially suited to this type of computation. The typical form of the regression equation is:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + u$$

Where: Y = observation of a dependent variable = a factor which is effected by the independent variables in the equation.

X_i ($i = 1, \dots, n$) = observation on independent variable of associated independent variable factor(s) which effects the dependent variable, but is not effected by it.

α = constant population parameter

β_i ($i = 1, \dots, n$) = regression coefficient representing the magnitude of the relationship between X_i and Y ; for every unit change in X_i there will be associated with it a β_i change in Y , assuming $X_2, \dots, X_n$ are constant.

u = observation of the random error term.

If we now assume that all values of u observed are independent random variables, we then obtain the following estimating equation: $\hat{Y} = a + b_1 X_1 + b_2 X_2 + \dots + b_n X_n$

Where: $\hat{Y}$ = estimation or calculated value of Y ;
 a and b are estimates of α and β

Additional results may be obtained from the normal regression analysis test.¹ Some of the other information obtained include the multiple correlation coefficient (R),

¹Kiel, D.F., and W.L. Ruble. "Formulas Used in CORE Routine," A.E.S. Program Description 12, Oct. 15, 1963, pp. 4-9, Michigan State University Computer Laboratory.

the standard error of estimate ($Sy.x$), standard error of coefficients (Sb_1), t-value for testing if the b_1 is different from zero (Tb), residuals ($\bar{u}_t$) and coefficients of multiple determination (R^2) along with others, where:

$$R^2 = \frac{SSR}{TSSAM} \quad \begin{array}{l} SSR = \text{sum of squares explained by regression} \\ TSSAM = \text{total sum of squares after mean} \end{array}$$

$$R^2 \text{ corrected for degrees of freedom} = \bar{R}^2 = \frac{1-N-1}{df} \cdot (1-R^2)$$

N = number of observations

$\bar{R}^2$ is often preferred to R^2 since $\bar{R}^2$ gives the exact split of the variance of Y , into explained and unexplained variance whereas R^2 splits the sum of squares.

$$R = \sqrt{R^2}$$

$$R \text{ corrected for degrees of freedom} = \bar{R} = \sqrt{\bar{R}^2}$$

$$Sy.x = \sqrt{s^2}$$

$$s^2 = \text{estimated variance of disturbance} = \frac{SSE}{df}$$

SSE = sums of squares of error

$$Sb_1 = \sqrt{sb_1^2} = \sqrt{c_1} \cdot s^2$$

c_1 = 1 th element of the inverse of the sums of squares

$$Tb = tb = \frac{b_1}{Sb_1} \quad Y = \text{true value of dependent variable}$$

$$\bar{u}_t = Y_t - \hat{Y}_t \quad \hat{Y} = \text{estimated value of dependent variable}$$

This author will not attempt to explain the calculations involved in the typical regression routine since detailed explanations of this routine are readily available.¹ Also,

¹Kiel, D.F., and W. Ruble. "Calculation of Multiple Regressions, Use of CORE Routine," A.E.S. Program Description 4, Sept. 30, 1963, Michigan State University Computer Laboratory.

the availability of computer services makes an understanding of the calculation technique unnecessary.

As can be readily noted, the regression analysis technique involves much more intricate calculations than either the chi-square or analysis of variance tests. It also provides more detailed results from which a more complete analysis can be made. It makes it possible to numerically measure the magnitude of the effect an independent variable has upon a dependent variable as well as enabling the user to make projections on the assumption that those relationships detected will remain constant over time. Also, the Tb value associated with each independent variable may be compared with the t -value of the t statistical table and, given degrees of freedom ($N-k-1$, where N = observations and k = parameters), it can be determined whether or not that particular variable is statistically significant in its effect on the dependent variable. For example, if $Tb_1 > t\text{-value}$, given degrees of freedom and α level, then the variable is accepted as being statistically significant.¹

However, this term "significant" must not be misinterpreted. Statistical significance may well have a completely different connotation from that of economic significance.

¹Testing the significance of the hypothesis that variable (X_i) has zero effect on the dependent variable, (Using a one-tailed test).

For example, the arbitrary use of .05 level of α may have no economic meaning if the difference in retail food sales is only \$100 per county. Likewise, many factors may be economically significant and yet show a TB too low to qualify as being statistically significant. For this reason, factors were selected, for their importance as a determinant factor, on the basis of the "most" significant (size of TB) rather than using the $TB \leq t\text{-value}$ criteria.

Choice of Statistical Test:

In summary, the regression analysis procedure was chosen over those of chi-square and analysis of variance for the following reasons:

- 1) Data on both dependent and independent variables are quantitative in nature and thus, can most effectively be analyzed by the regression technique.
- 2) It provides numerical measurements of the relationships between the variables and enables determination of those factors which are "most" significant.
- 3) It enables the user to formulate projections.
- 4) Provides adequate results from which a better overall analysis can be made as compared to the other alternative methods.
- 5) It allows for individual county analysis, using available information, and illustrates the heterogeneity between counties.

6) Numerical measurements aid in the economic interpretation of the relationships that may exist.

Regression Procedures Used in this Paper:

Time Series Analysis

The first regression equation to be used in this study is called the time series multiple linear regression equation.¹ Where a dependent variable is influenced not only by a single independent variable, as in the relation of Y to x_1 , but also by two or more independent variables, this relation can be represented symbolically by the following multiple linear regression equation:²

$$Y = a + b_1x_1 + b_2x_2 + \dots + b_nx_n + u$$

Where: Y = the dependent variable

$x_1, x_2, \dots, x_n$ = independent variables

As previously stated, the first objective to be reached in this study is to determine which of the factors, if any, described in Chapter III, have an appreciable effect

¹The term "multiple" is added to indicate that it explains Y in terms of two or more independent variables $x_1, x_2, \dots, x_n$. The coefficients b_1 and b_2 are termed net regression coefficients. The term "net" is used to indicate that they show the relation of Y to x_1 and x_2 , respectively, excluding the associated influences of the other independent variable or variables.

²Fox, Karl A, and Ezekiel Mordecai. Methods of Correlation and Regression Analysis. John Wiley & Sons, Inc., New York, 1959, p. 152.

on the gross retail food sales of a county, metropolitan area, or the entire state of Michigan. The multiple linear regression formula will be used to accomplish this task in the following way.

First, it has already been mentioned that the dependent variable of this particular equation is the gross retail food sales of a given area. Since the first test shall be a time series study, the annual volume of retail food sales in "County A" for the twelve year period of 1951-62 becomes the values of Y in the equation. Likewise, the data on the independent variables previously discussed (population, income, # food stores, etc.) becomes the values of $x_1, x_2, \dots, x_n$. The equation for County A then looks like: $Y = a + b_1x_1 + b_2x_2 + \dots + b_nx_n$.

Where: Y = annual gross retail food sales 1951-62
for County A

$x_1, x_2, \dots, x_n$ = income, population, etc. 1951-62 for County A.

Once the data is arranged in the above manner, it is subjected to trial run calculations. Results of this trial run should show the percent of variation in Y over the twelve year period that is explained by $x_1, x_2, \dots, x_n$, (R^2), the magnitude and direction of the effect on Y of each $x_1, x_2, \dots, x_n$, ($b_1, b_2, \dots, b_n$), the level of significance of each independent variable ($Tbb_1, Tbb_2, \dots, Tbb_n$), and a great deal of additional information not of particular interest in this study.

Those variables with low levels of significance or high inter-correlation are then dropped and the calculations again made. Eventually, an accurate equation is found showing the magnitude, significance, and percent of variation in Y explained by those variables selected. This process was completed for each of Michigan's 83 counties and the state for the twelve year period.

The following diagram may aid in the reader's understanding of the difference between the time-series analysis, just described, and the cross section analysis, soon to be discussed.

	County #1	County #2	.	.	.	County #3	State
	(#FS) (Per Cap. Income) (Retail Food Sales)						
1951							
2							
3							
4							
5							
6							
7							
8							
9							
1960							
1							
2							

The time series analysis involves the calculation of 84 multiple linear regression equations, one for each of the COLUMNS of data. The cross-section analysis, however, involves

the calculation of 12 equations, one for each of the ROWS of data.

Cross Sectional Analysis

Next, a cross-sectional study is conducted. The statistical procedure is much the same, except each equation represents variation in food sales between counties for a given year, rather than variations over a time period (12 years) for a given county. Whereas the time series equations were used to describe changes in gross retail food sales over time for each county, the cross-section equations now describe variations between counties for any given year between 1951-62. The variables used were those found important in the time series analysis.

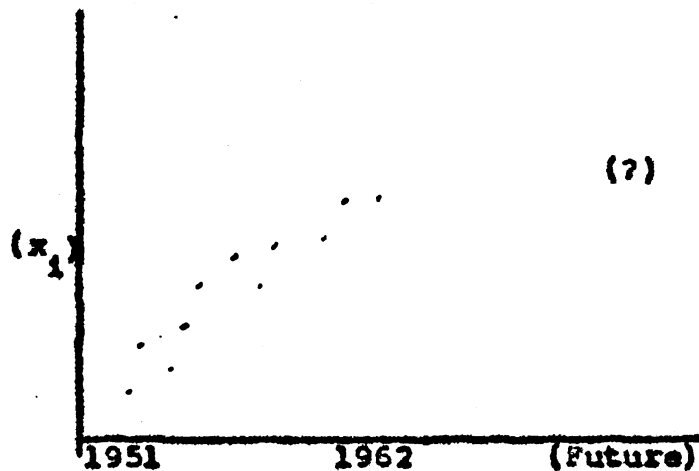
Simple Curvilinear Regression Equation

Once the significant factors have been determined, one major step remains before projections can be made. By assuming those relationships found in the multiple linear regression equations will remain constant over time, estimated values of $x_1, x_2, \dots, x_n$ for a future year may be placed into the equations and an estimated value of Y , for that year, calculated. However, the accuracy of this estimated or projected Y depends not only on the accuracy of the equation, but also on the accuracy of the estimated values of $x_1, x_2, \dots, x_n$ entered in the calculations. Therefore, the major step now being considered, is the accuracy of the projected values

of the selected independent variables.

Since the causes behind the value of a given independent variable is not of particular interest, these necessary projections need only be made as a function of time. For example, Figure 2 illustrates the situation now faced.

Figure 2
Curvilinear Projection as a Function of Time



Various techniques are available for estimating the value of x_1 in a future time period. Freehand, moving average, or least squares trend lines may be drawn through the given values of x_1 and extended outward toward the future year of interest. However, more accurate trend lines may often be obtained by using a simple curvilinear regression equation as shown:

$$Y = a + b_1x_1 + b_2x_1^2$$

Where: Y = selected independent variable (x_1 in Figure 2)

x_1 = time

Mathematical curves will have a distinct advantage over freehand and other methods when there is a logical basis for expecting a certain type of relation to hold. When there is a logical basis for using a given formula, the constants of the equation serve as an explanation of the nature of the relationship. In most other cases, the mathematical curve is no more reliable than the other methods.¹

The above equation is calculated for each of the selected variables for each of the 83 counties. Results of these calculations will be similar to those of the multiple linear regression. Once a , b_1 and b_2 have been determined, the values for the specific future year is incorporated into the simple curvilinear equation and an accurate estimate of the value of $s_1, x_2, \dots, x_n$ is derived and these values then placed into the multiple linear equation to obtain the potential retail food sales of a given county in a given year. In the following chapters, this entire process will be illustrated in detail for five selected counties, and a more detailed understanding thereby derived.

¹Fox and Ezekiel, p. 109.

CHAPTER V

SELECTION OF SIGNIFICANT VARIABLES AND FINAL REGRESSION EQUATION

As stated in the previous chapter, the important variables are selected on the basis of test results using multiple linear equations in a series of trial run calculations. This chapter explains the procedure used to select the final variables and regression equation.

County Selection

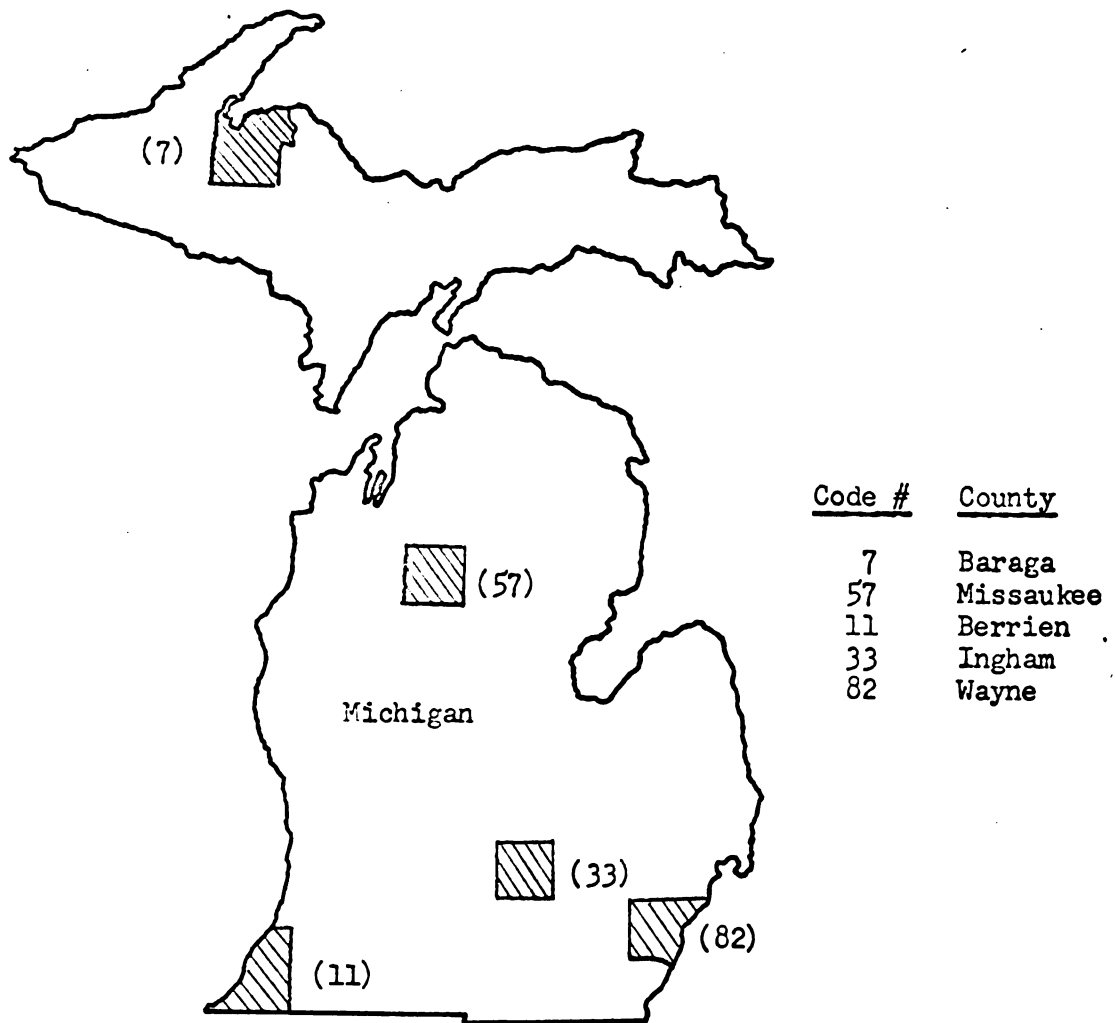
Rather than conduct an experiment involving all of Michigan's 83 counties, five counties were selected to represent most of the various types of counties found in the state. These five counties could then be carefully analyzed and the resulting variables used in equations for the other 78 counties.

Map #2 illustrates the location of the five selected counties.

Baraga - This county is representative of the counties in the Upper Peninsula. Its residents are primarily rural dwellers with low incomes. The county is very sparsely populated and has a large tourist influx during the summer months.

Missaukee - This county is typical of counties in the northern portion of the Lower Peninsula. Here, also, most of the people are rural residents receiving a low income from their

Map #2
Selected Counties



farming or logging enterprise. It has a relatively high summer tourist population.

Berrien - This county was selected to represent the southwestern portion of the state. Here the population is more dense, incomes are higher and the rural-urban population is about equally distributed.

Ingham - This county represents central Michigan and is characterized by a high per capita income, fairly heavy population density and a high percent urban population.

Wayne - This county represents southeastern Michigan. It is the most heavily populated county in the state, it has a high percent non-white population and almost all of its residents live in urban communities.

The above five counties represent statewide variations in geographical location, population, population density, percent rural-urban population distribution, income level, percent non-white population, etc. By analyzing these typical counties, it is easier for the reader to establish limits within which the discussion will remain valid. Even though only the five selected counties will be discussed in detail, regression equation results for all counties are presented in the appendix so that the reader, specifically interested in one of the remaining 78 counties, can perform an analysis similar to the one discussed in this paper, on any particular county or group of counties. Throughout the remainder of this paper, the discussion shall pertain directly to the five selected counties, metropolitan areas, and the state as a whole.

Trial Run #1:

The first calculation used the following equation.

$$Y = a + b_1x_1 + b_2x_2 + \dots + b_9x_9 + u$$

$$\text{Where: } Y = \left(\frac{x_{11}}{x_{12}} \right)_{100}$$

- x_1 = population density
- x_2 = sales volume per store
- x_3 = sales volume per person
- $x_4 = \left(\frac{x_{13}}{x_{14}} \right)_{100}$ (deflated disposable per capita income)
- $x_5 = \left(\frac{x_{15}}{x_{14}} \right)_{100}$ (deflated disposable per family income)
- x_6 = percent non-white population
- x_7 = percent urban population
- x_8 = number of food stores
- x_9 = population
- x_{11} = gross retail food sales
- x_{12} = food price index, 1950=100
- x_{13} = per capita disposable income
- x_{14} = consumer price index, 1950=100
- x_{15} = per family disposable income
- u = random error

The above equation shows how almost all factors mentioned in Chapter III were considered in the first trial run.

Use of Index

Before continuing, the use of the food price and the consumer price indexes must be explained and justified.

An index is most often defined as a numerical device used to compare the magnitudes of two or more related factors. To be more precise, the indexes in this equation were used to deflate the existing values of gross sales and income so as to remove effects of changing price levels. Since all sales data are presented in terms of dollar value, currently existing in the year represented, any projection of this data into the future would be extremely misleading when compared to

present price levels. Before the past, present and future sales volume data can accurately represent the physical volume implied, the inflationary effects of price rises must be eliminated. Likewise, income levels must be adjusted so as to depict its true purchasing power.

To accomplish this adjustment, a food price index was used to deflate the price of food and a consumer price index was used to render income levels more representative of its true purchasing power.

The consumer price index, derived from the Bureau of Labor Statistics¹ is a statistical measure of changes in prices of the goods and services bought by consumers. It measures only changes in prices; it tells nothing about changes in the kinds and amounts of goods and services consumers buy, or the total amount spent for living, or the differences in living costs in different places. It uses the "market basket approach" in determining what products are priced. The index market basket is an estimate of the goods and services bought by the consumer to use, replace and add to their possessions to keep up their level of living of a given base year. Since this index represents the changes in the price level of consumer's market basket, it then becomes an indicator of that consumer's purchasing power as compared to a base year.

¹Wirtz, Willard W. "The Consumer Price Index," U.S.D.L., Bureau of Labor Statistics, January 1959, p. 1.

The food price index is a measure of the price changes of only the food products within the market basket. It then provides a numerical measure of the food price changes over time and enables one to eliminate the inflationary portion of gross sales, leaving data more representative of actual physical volume of food¹ compared to a base period.

Index Assumptions

Despite almost constant revision, these indexes are not exact measurements.² They are subject to the many kinds of limitations that are always present in statistical calculations. In the language of the statistician, these limitations are called "errors."³ This should not be interpreted to mean that they are mistakes, and, for purposes of this study, the indexes are assumed to be accurate.

Also, assuming that all areas of Michigan are equally affected by any national inflation (or deflation), the two national indexes were applied to each county's data. So as to make this uniform as well as applicable to the time period being studied, both indexes were adjusted to the base year of

¹Volume still reflects the increase in food sales value due to increased services in product.

²"C.P.I.," Food Field Reporter, February 3, 1964, p.22.

³Vaughan, Olive E. "An appraisal of the B.L.S. Consumer Price Index," Journal of Marketing, October 1953, 18: 133-45.

1950. Below are listed the values used for each year 1951-62.

<u>FOOD PRICE INDEX</u>				<u>CONSUMER PRICE INDEX (Income Index)</u>			
<u>YEAR</u>	<u>INDEX</u>	<u>YEAR</u>	<u>INDEX</u>	<u>YEAR</u>	<u>INDEX</u>	<u>YEAR</u>	<u>INDEX</u>
1950	100.0	1957	114.1	1950	100.0	1957	117.0
1951	111.3	1958	118.9	1951	108.0	1958	120.2
1952	113.3	1959	117.0	1952	110.4	1959	121.1
1953	111.6	1960	118.3	1953	111.2	1960	123.0
1954	111.3	1961	119.7	1954	111.7	1961	124.3
1955	109.7	1962	120.8	1955	111.3	1962	126.7
1956	110.5			1956	113.0		

Expected Results

Before discussing the test results of trial run #1, it might be helpful to illustrate the factor trends in the various counties and mention some relationships that might be expected to show up in the results.

Retail Food Sales - Table 7, in Chapter III, shows how gross retail food sales increased in each county during the twelve year period; Ingham county leading with almost a 50 percent increase. There is a noticeable drop in 1955 which may be attributed to a sharp national recession in the early part of that year. Also, there is a noticeable leveling-off of the increase during the more recent years. Figure 3 illustrates the trend for the state as a whole.

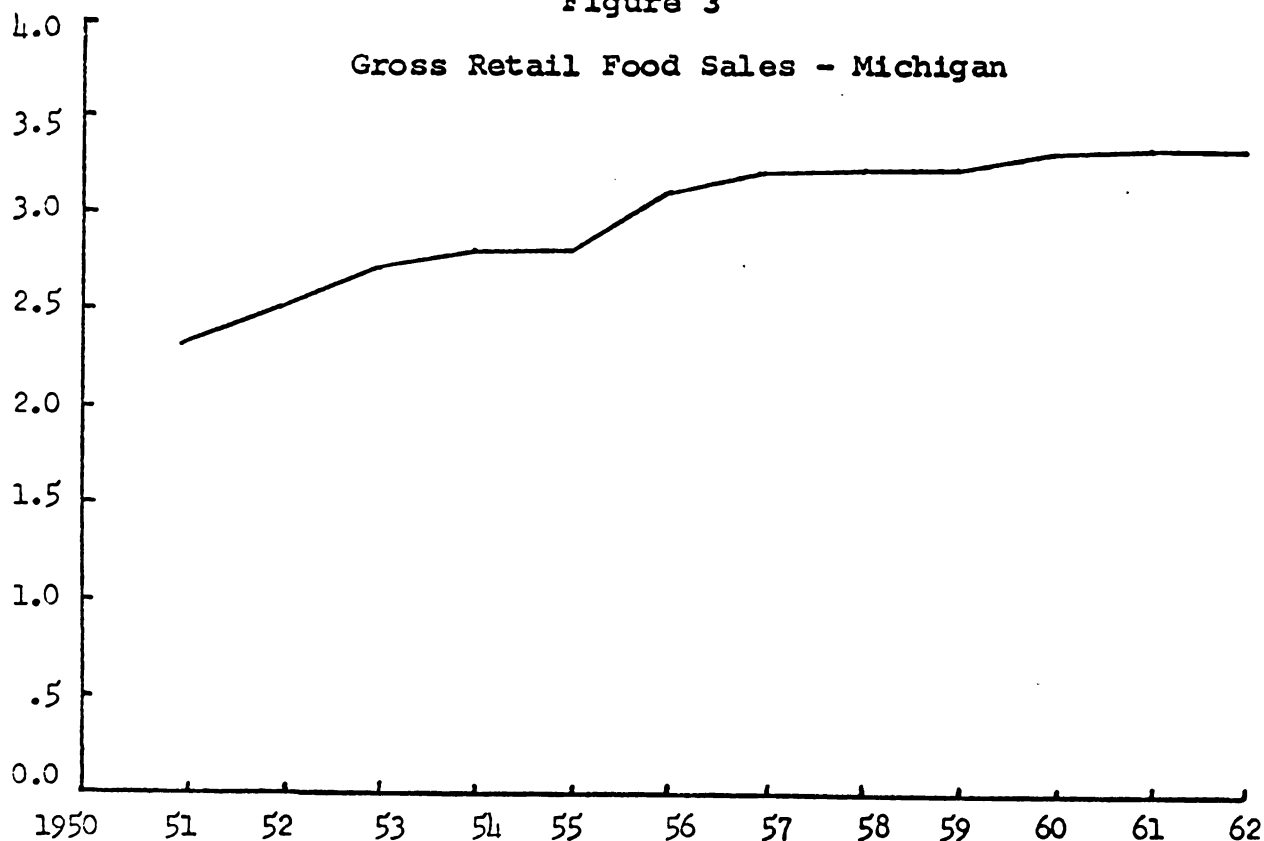
Population - Tables 8-11 in Chapter III illustrate the trends in the population characteristics of the various counties. Figure 4 illustrates the state trend. Notice the regularity of this increase along with the slight upward-bending tendency. This phenomena is certainly expected, when considering the

geometric expansion concept of the Malthusian Theory. It is expected that the population data would have a positive effect on gross retail food sales.

(\$000,000,000)

Figure 3

Gross Retail Food Sales - Michigan



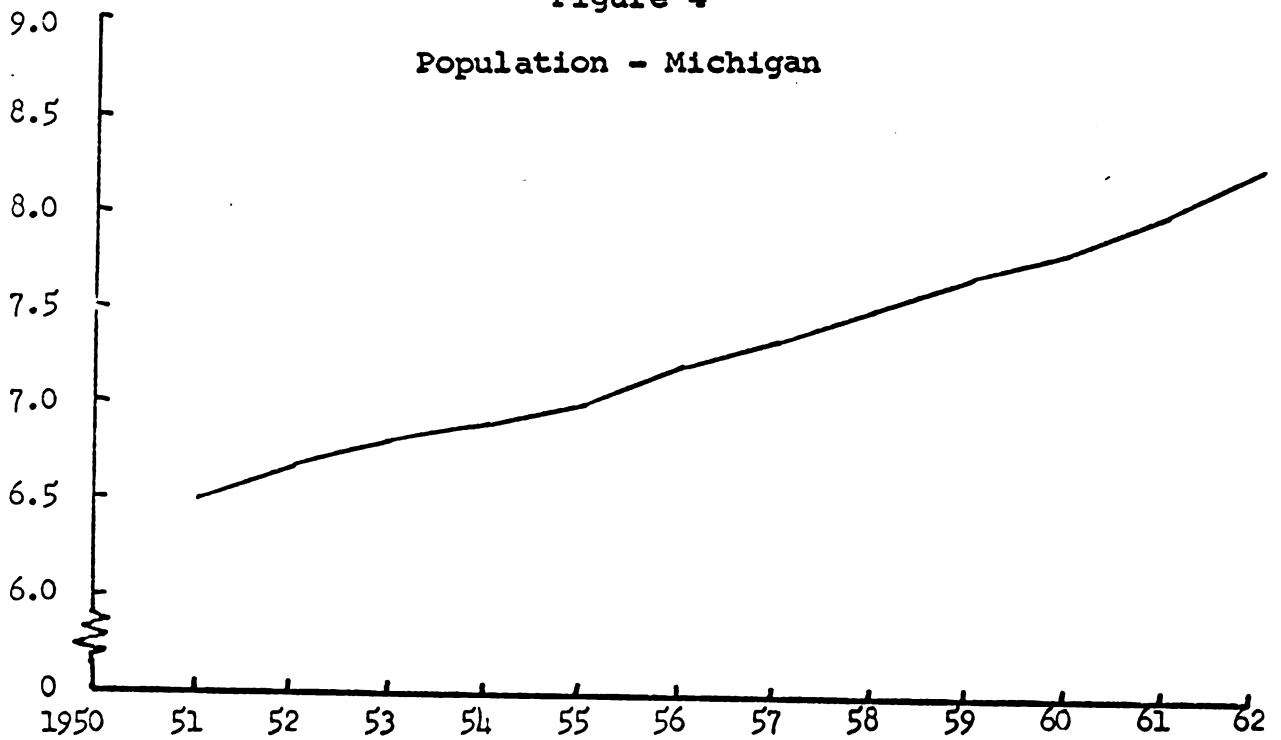
Percent Non-White - Figure 5 shows a distinctive increase in the percent non-white population. As explained in the Jewel Tea study, it would be expected that this factor would have a slightly negative effect on gross retail sales.

Population Density - Likewise, Figure 6 shows a fairly constant increase in the population density of Michigan and this is expected to have a positive influence on gross retail food sales, since, as was previously discussed, increased population density indicates an increase in the size of the local market.

(000,000)

Figure 4

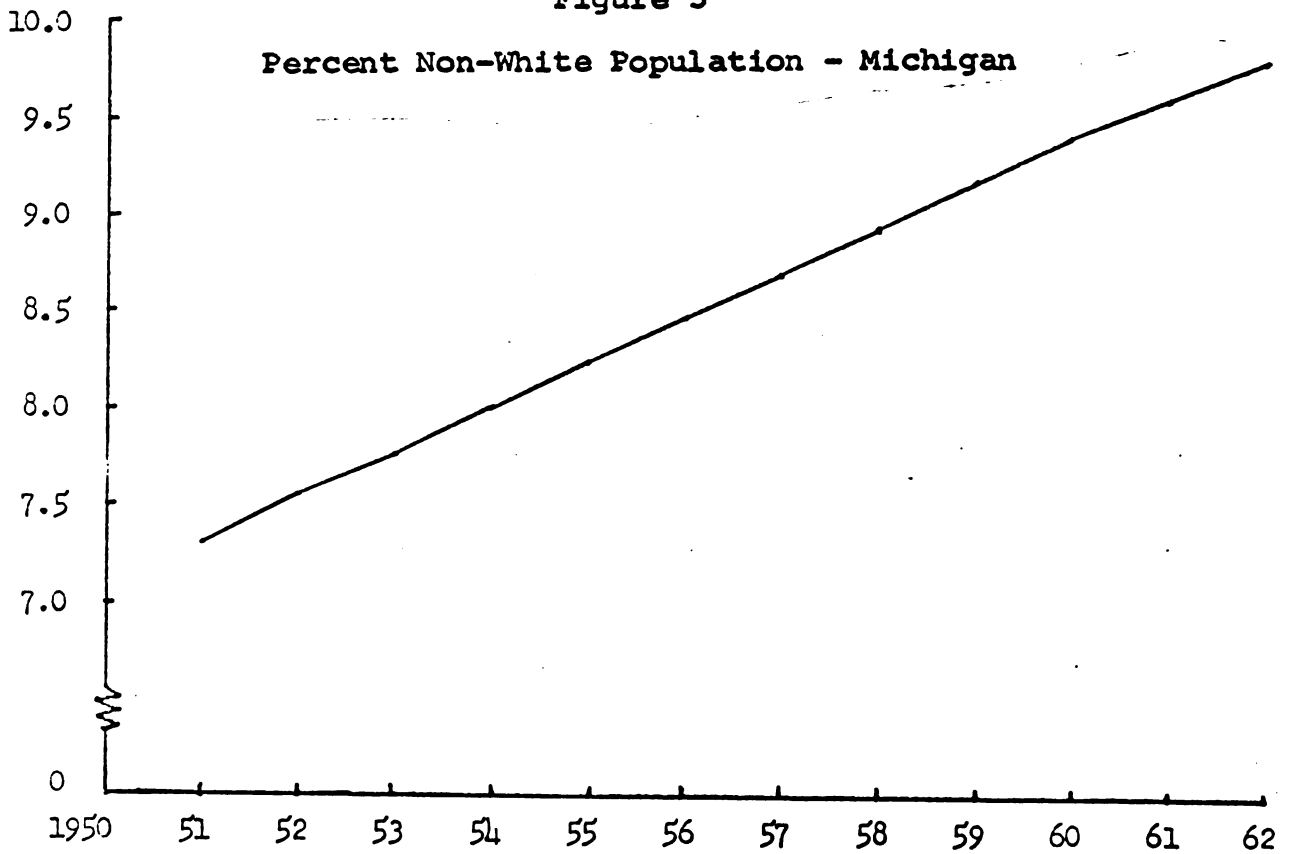
Population - Michigan



(%)

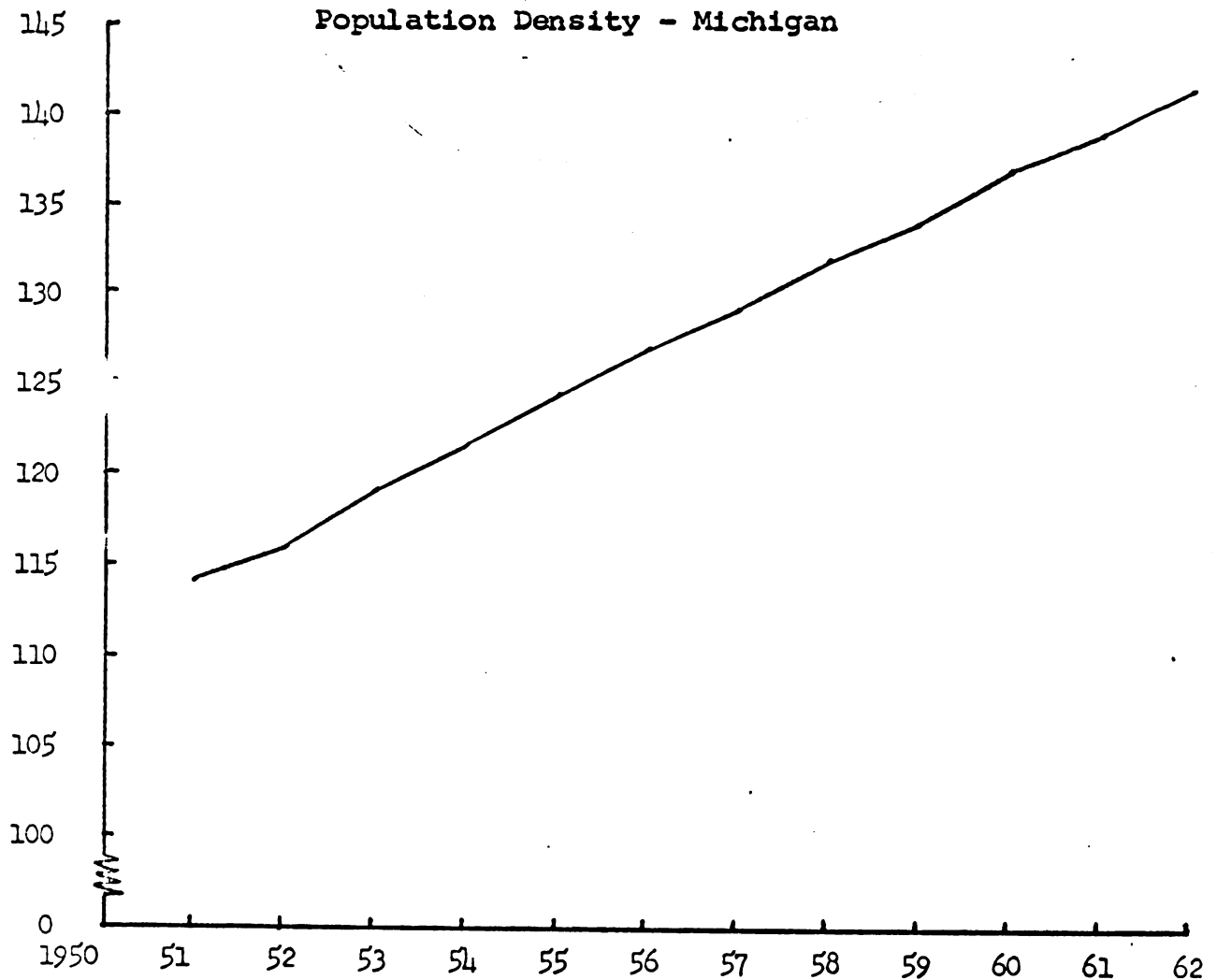
Figure 5

Percent Non-White Population - Michigan



(Persons/Sq. Mile)

Figure 6

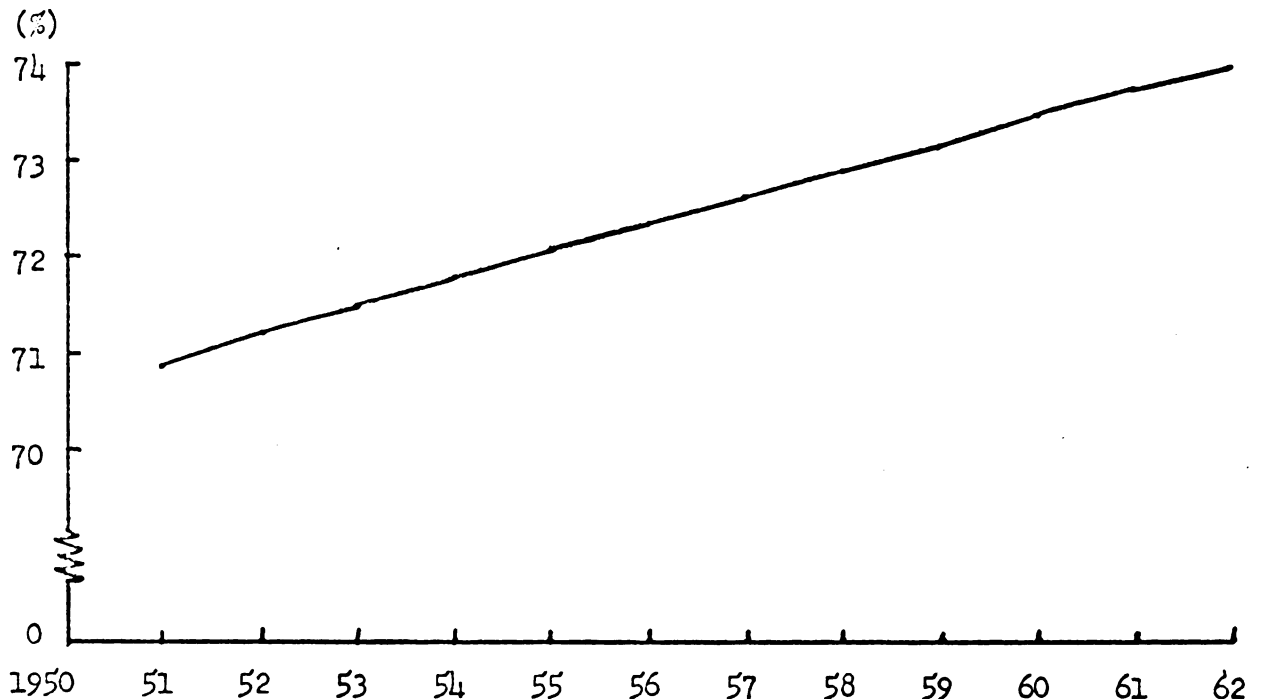


Percent Urban Population - Figure 7 shows almost a linear increase in the percent urban residents. However, this increase can be expected to taper off slightly in the near future. Nevertheless, it is expected that increased percent urban residents will produce a positive effect on gross sales.

Number of Food Stores - No estimate of the effect can be made here since past studies and economic reasoning differ in their resulting effects. While general marketing theory might

Figure 7

Percent Urban Population - Michigan



indicate that an increase in food store numbers would slightly increase total food sales, past studies in this area show a negative effect. Additional information will be given later in this paper to illustrate whether the trend shown in Figure 8 produces a positive or negative effect on gross retail food sales. Table 12, in Chapter III, shows a general decrease in store numbers for each of the five selected counties.

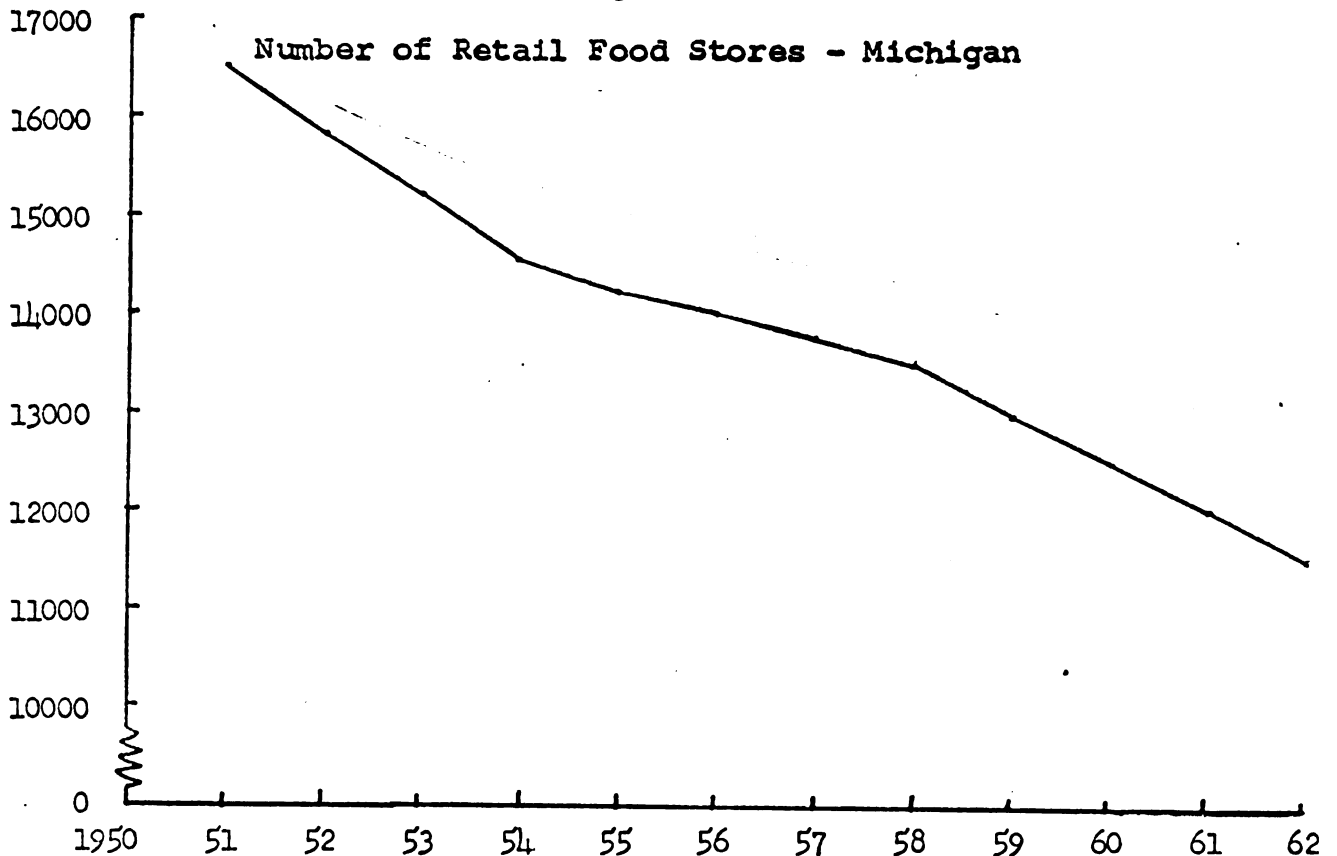
Additional Population Characteristic¹ - Among the most dramatic

¹Beegle, Allen J., Phadtare, Hambir, and John F. Thayden. "Michigan Population 1960, Selected Characteristics and Changes," Department of Sociology and Anthropology, Special Bulletin 438, Agricultural Experiment Station, Michigan State University, E. Lansing, Michigan, p. 7.

changes in Michigan population is its growing centralization. Twenty-three counties account for no more than one-third of one percent of the total population. Wayne, Oakland, and Macomb counties, combined, on the other hand, account for nearly one-half of the state total. Approximately one-fourth

(Number)

Figure 8



(22) of the counties have no urban population, that is, no place having as many as 2,500 people. At the other extreme, approximately one-fourth (23) of the counties are more than half urban.

Population growth or decline is a result of a combination of the balance of births and deaths and of selective migration. Differences in rates of change between county

units in a state, for instance, are more likely to be due to the effects of migration than the effects of natural increase. Eighteen counties actually experienced losses in their total populations between 1950 and 1960.

Due to the expected importance of the effect of population on retail food sales, additional population maps are presented in Appendix E to simplify the reader's understanding of Michigan's population composition and trends.

Income - Figure 9 shows a general increase in per capita disposable income and this also would be expected to exert a positive influence on gross sales. Table 13, in Chapter III, illustrates how the income level is lower for the northern county residents.

Sales Per Store - Sales per store was included in the trial run as a measure of market concentration. The greater the degree of market concentration (percent of area sales handled by one store), the smaller the potential food sales expected. Also, any market which is highly concentrated generally provides a strong entry barrier to any prospective retail outlet. Table 14 and Figure 10 illustrate the present trend, which is expected to have a negative effect.

Sales Per Person - This factor was included in the trial run to act as an indicator of the trend in per capita food expenditures. Naturally, an increase in food sales per person would have a positive effect on total food sales. Table 15

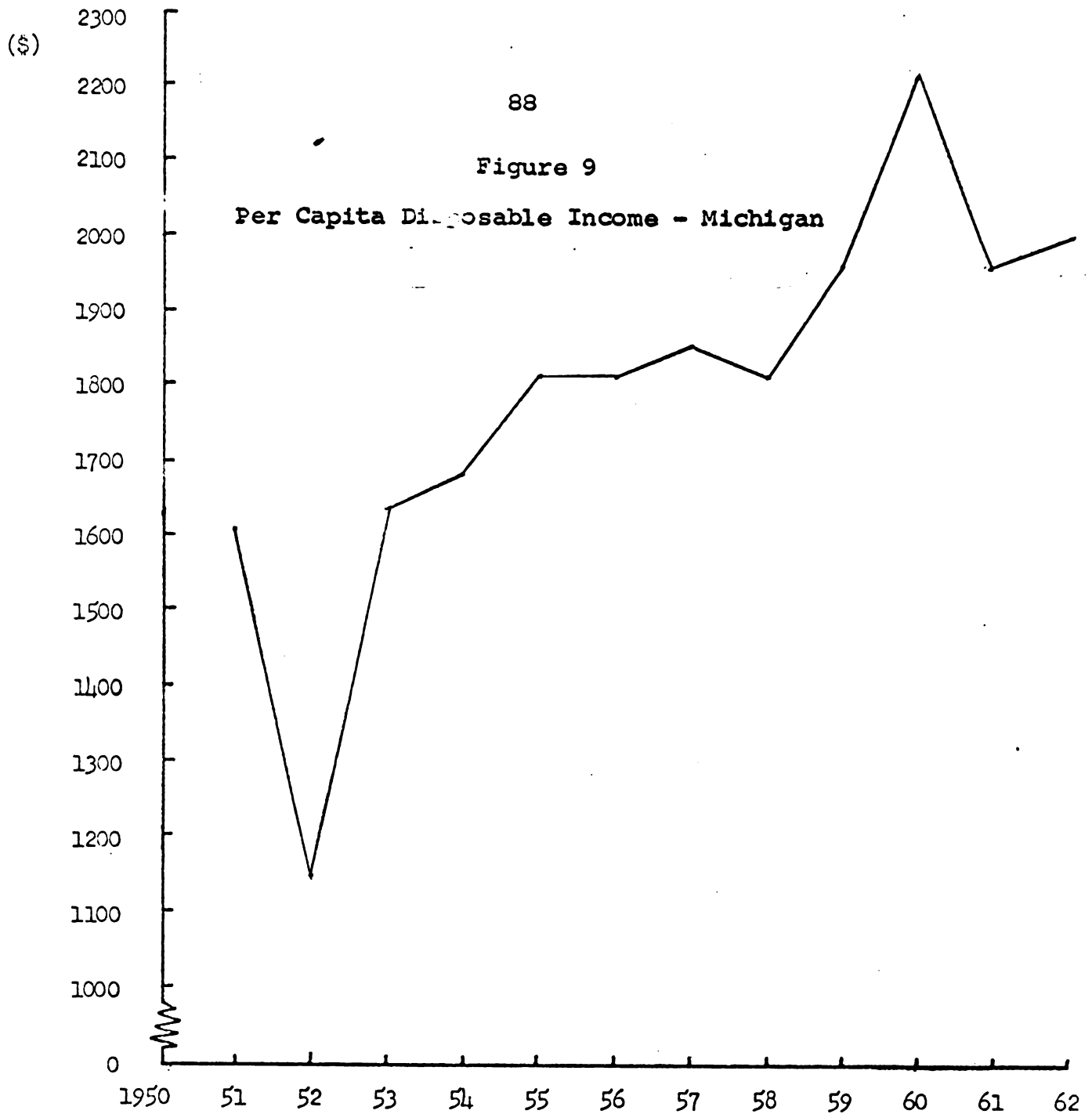
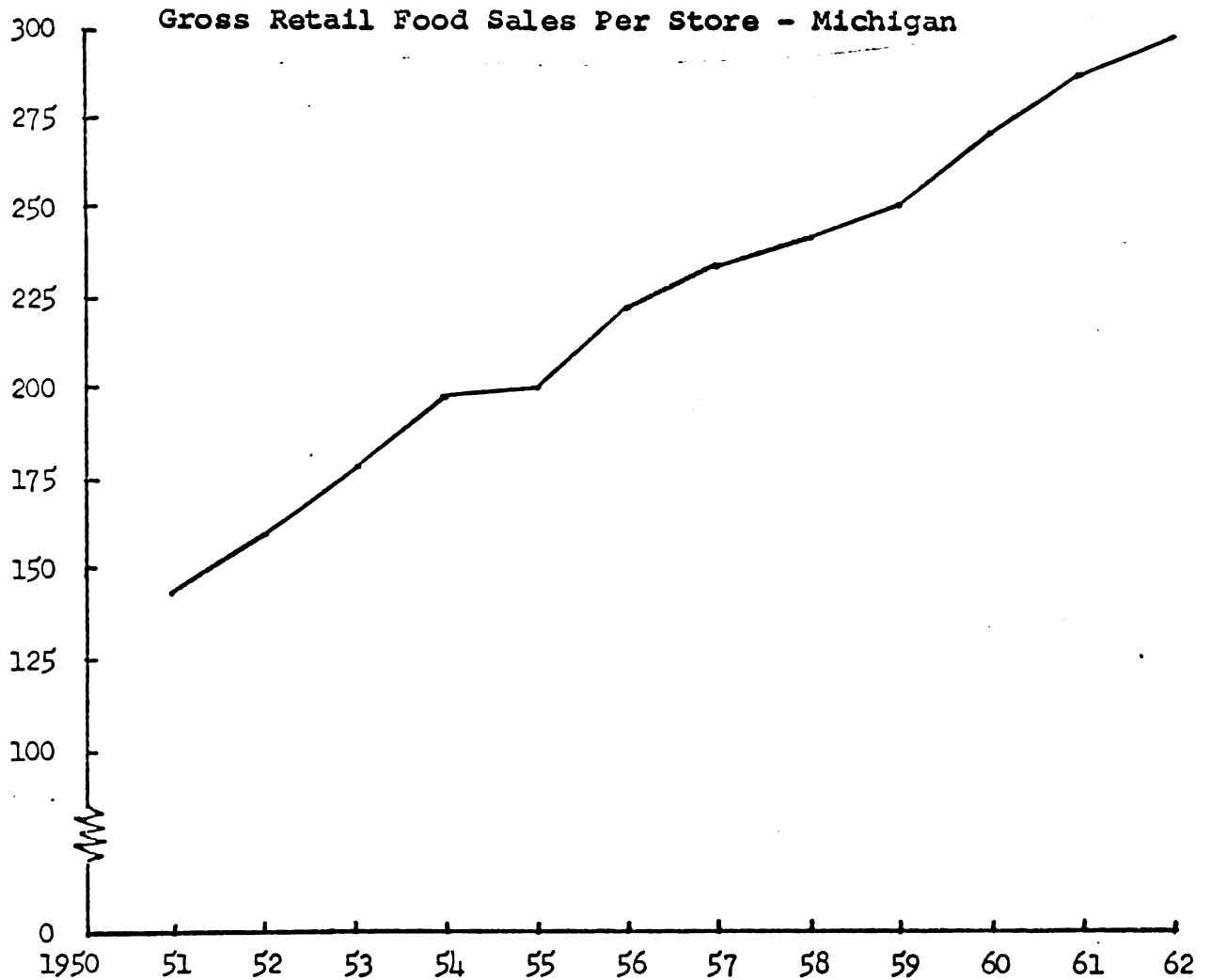


Table 14. Gross Retail Food Sales Per Store.

	(\$000)					
	Baraga	Missaukee	Berrien	Ingham	Wayne	State
1951	93.9	59.8	109.3	141.5	109.1	143.9
1953	105.7	63.4	129.9	168.5	127.3	177.7
1955	117.5	67.0	150.5	195.5	145.5	200.0
1958	135.2	72.4	181.4	236.0	172.8	241.3
1960	147.0	76.0	202.0	236.0	191.0	269.9
1962	158.8	79.6	222.6	290.0	209.2	290.2

(\$000)

Figure 10

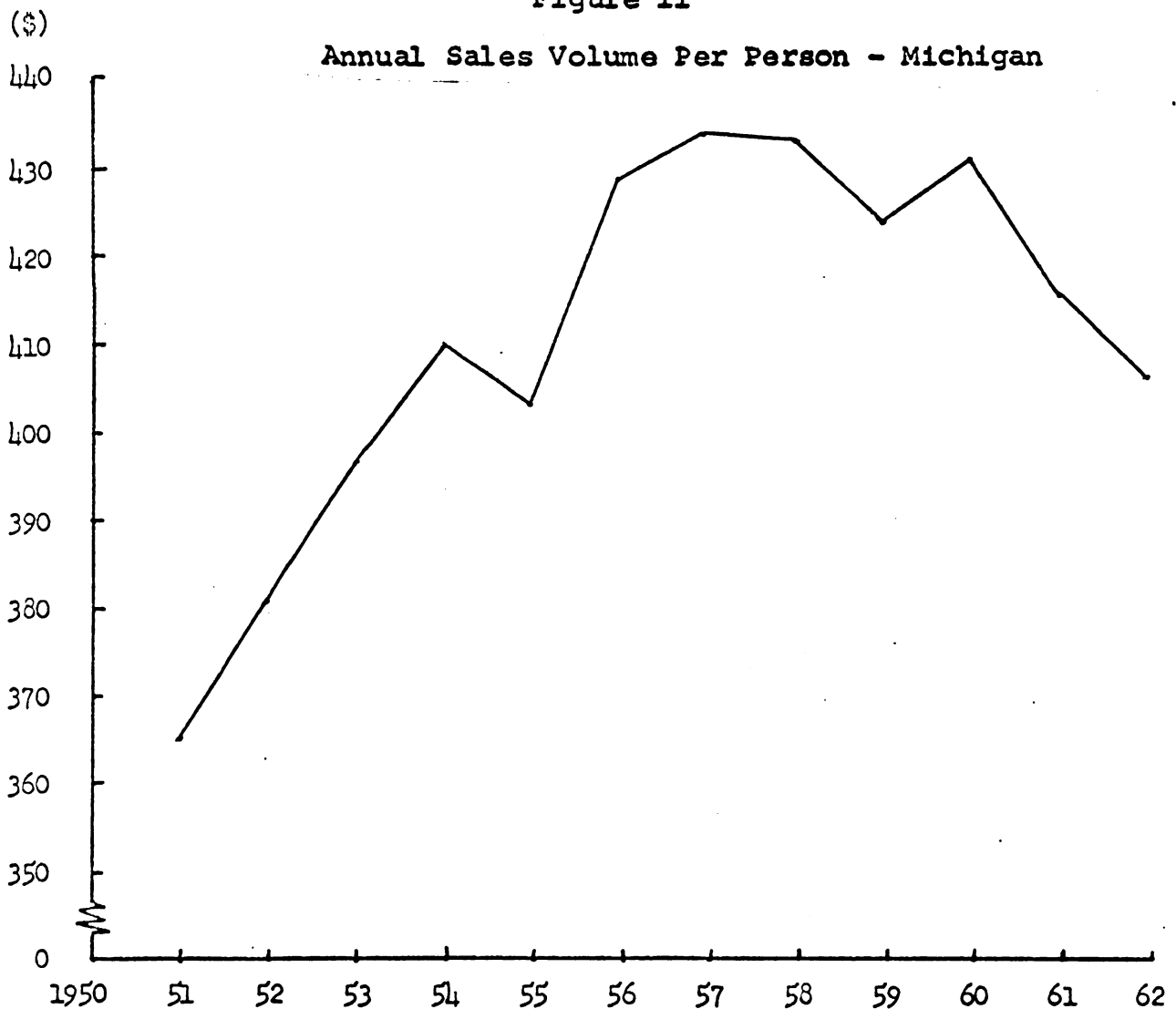


and Figure 11 show an increase in per capita food expenditures. Note, however, that this data does not necessarily indicate an increase in the quantity of food consumed, but may be the result of increasing food prices and/or increased purchase of the higher priced foods.

Table 15. Gross Retail Food Sales Per Person.

	(\$)					
	Baraga	Missaukee	Berrien	Ingham	Wayne	State
1951	206.40	168.30	279.90	268.60	276.60	365.00
1953	217.20	174.90	291.70	283.80	287.80	397.00
1955	228.00	181.50	303.50	299.00	299.00	403.00
1958	244.20	191.40	321.20	321.80	315.80	433.00
1960	255.00	198.00	333.00	337.00	327.00	431.00
1962	265.80	204.60	344.80	352.20	338.20	406.00

Figure 11



In summary, the previous discussion found the possible determinant factors to exhibit the followings:

<u>Factor</u>	<u>Trend 1951-62</u>	<u>Expected Effect¹</u>
Population	Up	+
% Non-white Population	Up	-
Population Density	Up	+
% Urban Population	Up	+
# Food Stores	Down	?
Per Capital Income	Up	+
Sales per Store	Up	-
Sales per Person	Up	+

MULTIPLE LINEAR REGRESSION ANALYSIS

Results: Trial Run #1

Now that the components of the possible regression equation have been discussed, the actual test can be conducted and further progress made towards the final selection of variables.

In trial run #1, as expected, negative coefficients (b_1) were found for the following variables: Non-White Population (x_6); Sales Volume Per Store (x_2). Although not anticipated, a negative coefficient was also found for the factor, number of food stores (x_3). The remaining variables were preceded by positive coefficients, indicating a positive effect on gross retail food sales, as was expected. However, the magnitude and the significance of each factor could not be accurately measured with the use of the test results. This was because of the extremely high degree of intercorrelation

¹ + Increase in factor value increases gross retail food sales.
 - Increase in factor value decreases gross retail food sales.

between some of the variables, causing the existence of a singular matrix, which is mathematically unusable in this type of calculation. High degrees of intercorrelation were found between the following sets or groups of variables, indicating the formula's inability to accurately attribute an effect on Y to either of two or more factors.

<u>Group</u>	<u>Factor</u>	<u>Intercorrelation</u>
I	(x ₆) % Non-White Population	.995-.999
	(x ₇) % Urban Population	
	(x ₁) Population Density	
	(x ₉) Population	
II	(x ₅) Per Family Income (Deflated)	.990-.993
	(x ₄) Per Capita Income (")	

In Group I, all five counties and the state showed high intercorrelations between population and the three population composition characteristics. This is not unusual since population data, alone, directly affects the values of the three components. Thus, it was decided to drop the three population characteristic variables from the equation and use only population.

In Group II, per family and per capita income were also found to be high intercorrelated. This, also, was not totally unexpected since average family size within the state does not vary greatly over time. Thus, per family income was also dropped from the equation, leaving per capita income.

Following the above adjustments the equation now reads as follows:

$$Y = a + b_2x_2 + b_3x_3 + b_4x_4 + b_8x_8 + b_9x_9 + u_2$$

This equation was then used in the calculations of trial run #2.

Results: Trial Run #2

As in trial run #1, the following two groups of variables were found to be highly intercorrelated:

<u>Group</u>	<u>Factor</u>	<u>Intercorrelation</u>
I	(x_1) Sales Volume Per Store (x_2) Number of Food Stores	.993-.997
II	(x_3) Sales Volume Per Person (x_9) Population	.99-.998

Again, Groups I and II were more or less expected since sales volume per store was directly related to the number of stores and sales volume per person was directly related to population. Thus, both sales volume per store and per capita were eliminated, leaving the following equation to be calculated in trial run #3.

$$Y = a + b_4x_4 + b_8x_8 + b_9x_9 + u_3$$

Results: Trial Run #3

The results of trial run #3 were similar to those in Ferber's study, where population (x_9) was found to be of such great importance, both in magnitude and in significance, that it completely concealed any relationships that might have existed between Y and per capita income (x_4) and/or number of food stores (x_8).

As previously mentioned, the relationship between population and food sales is primarily a bio-physical one, which contributes extremely little to any economic discussion

that might be of interest in this paper. Therefore, following the procedure of Ferber, the population factor is recognized as being of primary importance and adjustments are made so that other relationship can appear. This adjustment simply involves dividing population (x_9) into gross retail food sales (Y) to derive gross retail food sales per person, previously coded as x_3 .

The equation then appears as follows for the fourth trial run.

$$x_3 = a + b_4 x_4 + b_8 x_8 + u_4$$

Where: $x_3 = \frac{Y}{x_9}$ = gross retail food sales per person

x_4, x_8 = as listed under Trial Run #1

Results: Trial Run #4

The results from trial run #4 were much more conclusive showing no major trend interference and only a nominal amount of intercorrelation. Both factors (x_4, x_8) were found to have an effect on gross retail food sales per person. However, the magnitude, direction and significance of this effect differed between the five counties and the state. The results, as are shown in Chapter VI, were considered valid enough to suggest use of the following equation for all 83 counties:

$$100 \cdot \left[\frac{\left(\frac{x_1}{x_3} \right)}{x_2} \right]_{zq} = a_z + b_1 z x_4_{zq} + b_2 z \left\{ 100 \cdot \left(\frac{x_3}{x_8} \right)_{zq} \right\} + u_{zq}$$

Where: x_1 = gross retail food sales (previously x_{11})
 x_2 = food price index (previously x_{12})
 x_3 = population (previously x_{11})
 x_4 = number of food stores (previously x_3)
 x_5 = per capita disposable income (previously x_{13})
 x_6 = consumer price index (previously x_{14})
 z = counties no. 1-83 and state
 q = years 1951-62

Each equation explained the variations in per capita gross retail food sales by county over the twelve year period.

Cross Section Analysis:

Since the reader may also be interested in variations between counties as well as between years, a cross sectional analysis was also conducted and a similar multiple linear regression equation was used. However, in this computation, the values of the variables applied to each county for a given year, rather than to each year for a given county, as in the time series. In this case, the variations studied are those between counties rather than over time.

This computation produced an equation for each of the twelve years on which data was available. Each equation explains variations in per capita retail food sales among the 83 counties for each year 1951-62.

The numerical results of both the time series and cross sectional studies are presented and interpreted in Chapter VI.

PROJECTION MODEL FOR EXPLANATORY FACTORS

Coefficients, alone, are not adequate information for making projections. Also necessary, are estimates of the independent variable. By assuming the relationship found in the time series analysis to remain constant over time, the estimated gross sales can easily be calculated for each county if, and only if, accurate projected values of the independent variables are included in the computation. Thus, the values of the two selected independent variables must now be accurately projected into the future. Since the existence of factors affecting the values of the two independent variables is not of particular interest in this paper, extrapolation of the values using time as the determinant factor, seems quite sufficient. Figure 2 in Chapter IV will illustrate this technique; the objective being to compute an equation capable of accurately projecting the value of an independent variable to a given year. The following two simple curvilinear equations were computed for each of the 83 counties and the state, as a whole.

$$x_4 = a_1 + b_{41}x_T + b_{42}x_T^2$$

$$x_5 = a_2 + b_{51}x_T + b_{52}x_T^2$$

Where: x_4 = number of food stores
 x_5 = per capita disposable income
 x_T = year (time) 1951 = "51", etc.

Numerical results of these equations and their interpretation can be found in Chapter VI.

A projected county population is also necessary before the projected per capita sales volume can be transformed into projected total county gross retail food sales. However, simple geometric extrapolation will be used for this rather than a regression equation. The geometric expansion was found by Dr. Thaden, Demographer at Michigan State University, to be sufficiently accurate. Further discussion on this topic will be found in Chapter VII.

CHAPTER VI

PRESENTATION AND ANALYSIS OF COEFFICIENT ESTIMATES

Time Series Multiple Linear Regression Equation:

Presented below are the time series calculation results for the five selected counties and the state as a whole. Note the variations in the results between counties. A complete analysis of all equations is presented following each table.

Equation used:

$$100 \left[\frac{\left(\frac{x_1}{x_3} \right)}{\frac{x_2}{x_2}} \right]_{zq} = a + b_1 x_{4zq} + b_2 \left\{ 100 \left(\frac{x_5}{x_6} \right)_{zq} \right\} + u_4$$

Table 16. Time Series Equations.

County	Code #	$\frac{x_5}{x_6}$ (x_4 Inter. Corr.)	R^2	a	b_1	b_2	9 d.f.	
							TS_{b_1}	TS_{b_2}
Baraga	7	.1318	.855	406.3353	-13.9206	.0385	-8.1305	1.7557
Berrien	11	-.8133	.132	652.4422	-.3563	-.1263	-1.7063	1.8967
Ingham	33	-.4726	.351	335.8499	-.2604	.0675	-1.5495	1.3432
Missaukee	57	.1054	.828	68.4942	-7.4910	.2578	-2.9856	6.4352
Wayne	82	-.1455	.293	122.7371	.0097	.1296	1.2331	2.3992
State	84	-.597	.053	250.5143	.0016	.0553	.3705	1.4349

Inter-correlation varied among the five selected counties from a high of .81 in Berrien to a low of .10 in Missaukee County. Generally speaking, only Berrien County had a high enough intercorrelation so that no accurate estimate could be made as to the relative effect each independent variable had upon per capita deflated gross retail food sales. The state, as a whole, had an intercorrelation of .60 indicating a tendency for the analysis of the state to be less reliable than an analysis of an individual county within the state.

R^2 or $\bar{R}^2$ represent the percent of variation in food sales that was "explained by"² the two independent variables.¹ Table 16 shows Baraga to have the high $\bar{R}^2$ with .85 and Berrien County the low with .13. Again, the state analysis shows poorer results ($\bar{R}^2 = .05$) than that of individual counties.

Map 2 shows the county results of the entire state. Generally, there are great variations in R^2 throughout the state, with the only noticeable pattern being in the northwestern portion of the lower peninsula, where a high R^2 is evident. Other than this, no relationship is shown between geographical location, population, income, etc.

¹ $\bar{R}^2 = R^2$ adjusted for the degrees of freedom.

²"Explained by" is used rather than "caused by" since only economic phenomena can actually "cause" these variations.

Coefficient of Determination
(R^2)



The "a" (Table 16) represents a constant in each equation and its value indicates little other than the intercept of the regression line on the Y or vertical axis.

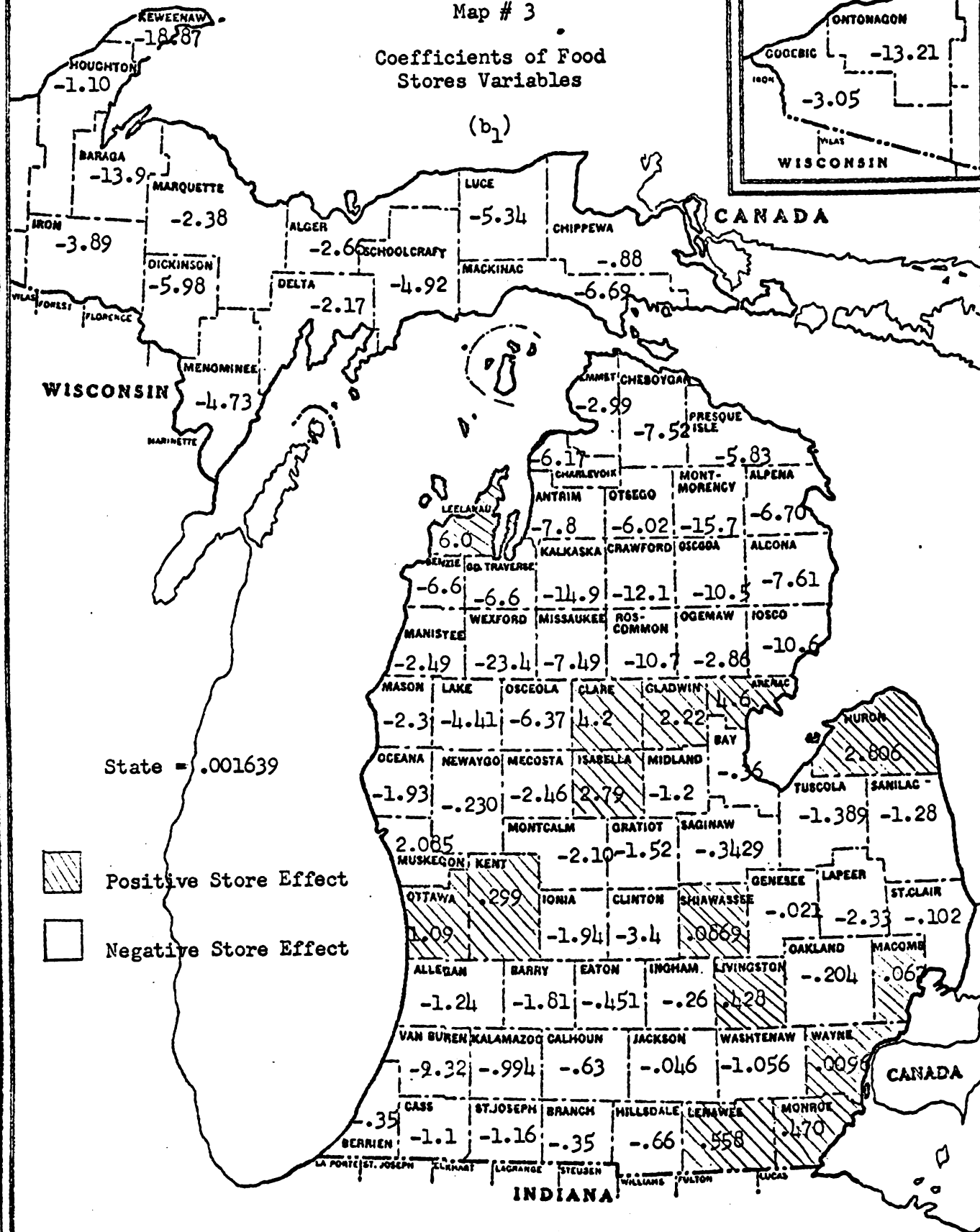
The " b_1 " (Table 16) represents the dollar magnitude of the change in a county's total deflated per capita retail food sales associated with a one unit change in that county's number of food stores, assuming all other independent variables are constant. Table 16 shows variations in b_1 from -13. (decrease of \$13.) in Baraga to .009 (increase of \$.009) in Wayne County. The state, as a whole, shows a slightly positive effect. Map 3 shows a distinct pattern of b_1 .

Map 3 shows a distinct pattern whereby the negative coefficient is prominent in the northern portions of the state and the positive effect more noticeable in the southern counties. Also, the negative effect is much larger in the most northern counties, and decreases in magnitude when moving southward. This negative coefficient indicates that as store numbers decrease, per capita retail food sales increase, while other variables are constant. For example, in Baraga County, as the number of food stores in the county decreases by one, annual per capita deflated retail food sales increase by \$13.90. However, in a southern county like Wayne, an increase in per capita food sales is partially explained by an increase in the number of food stores available.

An explanation of this pattern may be as follows: First, those food stores going out of business in the northern

Coefficients of Food Stores Variables

(b7)



State = .001639

Positive Store Effect

Negative Store Effect

0 5 10 20 30 40 50 60 MILES

part of the state are the small outlets (country stores) located in rural areas. Those stores remaining in operation, tend to be located in the more heavily populated areas of the county. These stores can still be found in the shopping district of the small town (less than 2,500 people). Many have moved into a new shopping center which may serve the entire county's population. Regardless, those remaining outlets can be found in an area surrounded by other retail establishments so they might take advantage of the increased drawing power. Therefore, county residents can travel to one major retail trading area and purchase many different types of retail goods. Such an area certainly possesses a larger amount of drawing power compared to country stores. This would coincide with the findings of Bernard Joseph LaLonde, previously mentioned,¹ where the existence of a shopping center store complex had a positive influence on drawing power and per customer sales.

Second, those stores remaining are generally the large sized outlets able to exhibit or stock a much greater number of food products. Normally, as the availability of diversified food products increases, so does the per capita food sales.

Second, those stores remaining are generally the large sized outlets able to exhibit or stock a much greater number

¹LaLonde, p. 120.

of food products. Normally, as the availability of diversified food products increases, so does the per capita food sales.

Third, the northern counties are not only experiencing a decrease in the number of food stores, but also an increase in the amount of annual tourism. Tourism is a factor not included in the computation of " b_1 " and therefore produces a bias due to this omitted variable. Since an increase in tourism normally would cause a rise in food sales, this trend toward increased tourism in the northern counties would tend to inflate the effect now attributed to a decreasing number of food stores. Therefore, the " b_1 " in the northern counties would tend to be larger compared to the southern counties.

Fourth, in the southern part of the state it is much more heavily populated and the existence of large modern shopping centers are more common. In general, the small country store had been eliminated prior to the observation period of 1951-62. The small positive effect found in some of these southern counties may then be attributed to the greater availability of more expensive prepared foods and other food products. This suggests that the "store effect" will be positive in more counties in the future as more areas advance to the present status of the southeastern Michigan counties.

The small positive effect derived from the state, as a whole, is attributed to the heavy weight, placed by a county such as Wayne on the state data. For example, 50 percent of

the state's total retail food sales occur in the Detroit metropolitan area, consisting of the three counties - Oakland, Wayne, and Macomb; two of which have a positive b_1 coefficient.

The " b_2 " represents the magnitude of change in deflated per capita food sales attributed to a one unit change in deflated per capita disposable income, assuming other independent variables are constant. For example, in Missaukee County, an increase of \$1. in deflated per capita disposable income would increase deflated per capita food sales by \$.25, assuming other variables are constant. Table 16 shows b_2 varying from .25 in Missaukee to -.12 in Berrien County. One would normally expect to find a positive relationship between income and food sales since an increase in income level makes possible an increased spending on all items, including food products. While analyzing the state, as a whole, a positive coefficient (.05) was found. Normally this would be universally applied to each and every segment of the state. However, as Map 4 so explicitly illustrates, this practice would seem to be in error. When analyzing the state on a county by county basis, one finds not only variations in the magnitude of the coefficient, but also in the direction of the effect. For example, Map 4 shows that 34 of the 83 counties have negative rather than positive coefficients.

These negative coefficients vary from -.003 to -.126. Those counties showing negative relationships seem to be evenly located throughout the state with no noticeable pattern.

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Map # 4

Coefficients of Per Capita
Disposable Income Variables(b₂)

WISCONSIN

State = .05526



Positive Income Effect



Negative Income Effect

0 5 10 20 30 40 50 60 MILES

INDIANA

CANADA

It is extremely difficult to explain why in certain areas of the state an increase in per capita food sales would be attributed to a decreasing per capita income level. One possible explanation may be that as income levels increase, the people decide to purchase a high cost durable good such as a new car or a house. The subsequent loan repayments then reduce the portion of income previously used for food purchases. It is my opinion that this phenomena may be applicable to a small portion of a county's population, however, its effect would be too small to alter the direction of an entire county. It is therefore obvious that additional study is needed in this area.

TB_{b_1} and TB_{b_2} are measurements of the statistical significance of the two independent variables. As previously stated, these two independent variables were selected as being the two variables "most" significant rather than whether or not they were "statistically" significant.¹ Nevertheless, it may be of some value to compare the α levels, at which the variables are statistically significant, among counties. Table 23, also in this chapter, provides the t-values from which the statistical significance may be determined. For example, both independent variables are statistically significant for Missaukee County at .02 level of α , but only at

¹Statistical significance refers to the rejection of the hypothesis that the variables have zero effect on retail food sales.

the .20 level of α for Berrien County. Again, it is noticed that both variables are generally not as significant for the state as they are for an individual county. Map 5 illustrates how the value of TB_{b_1} and TB_{b_2} may vary among the 83 counties. Again, there is no noticeable pattern in these values.

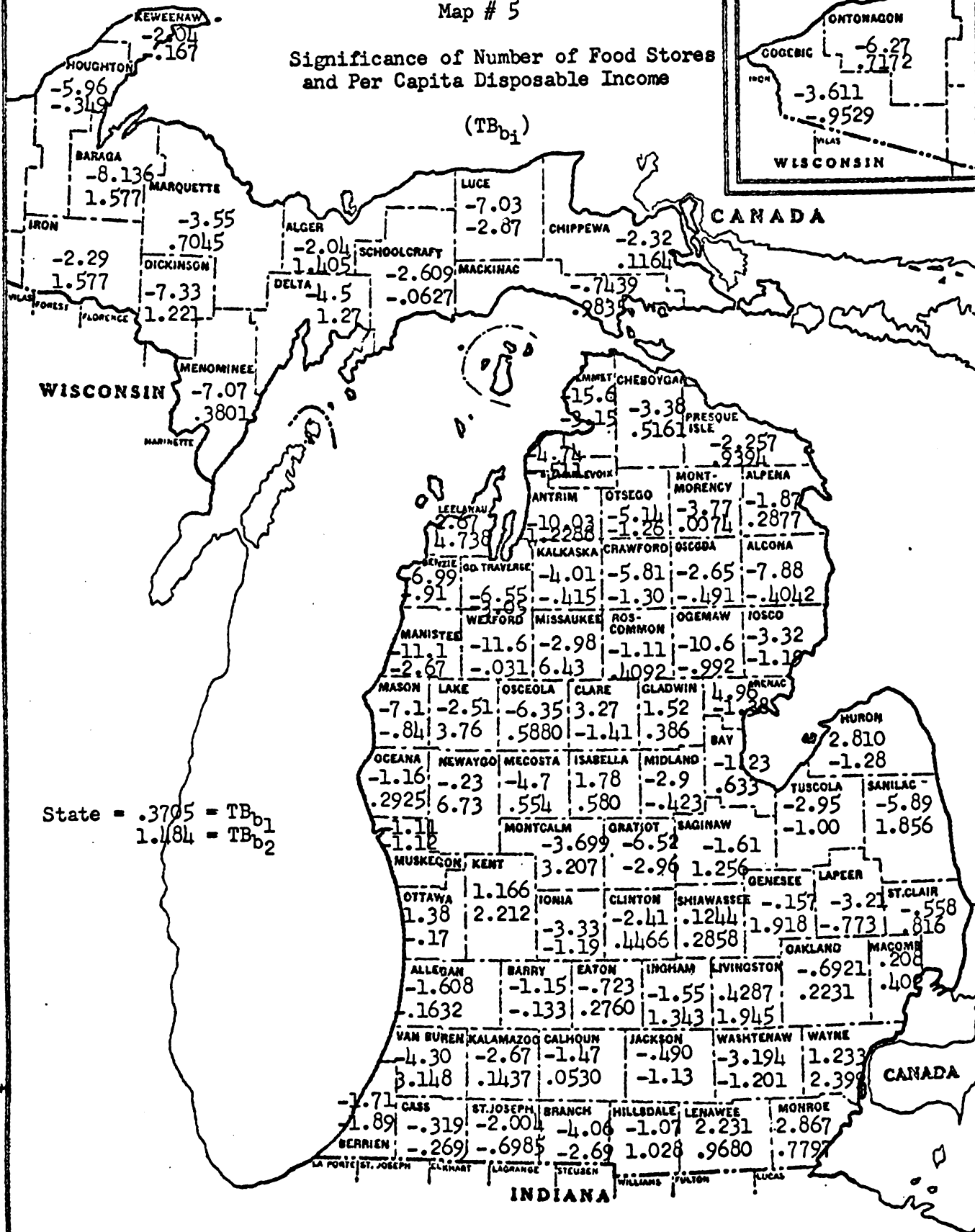
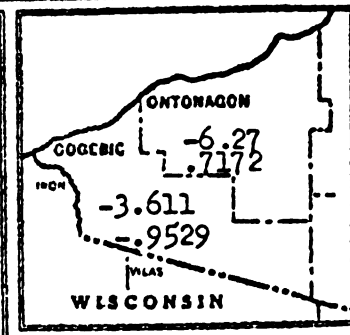
Cross Sectional Multiple Linear Regression Equation:

The computation of variations in retail food sales among all 83 counties for a given year produced the following results. The same form of equation used in time series calculations was applied to the cross section analysis.

Table 17. Cross Sectional Equations.

Year	Intercorr.	R^2	a	b_1	b_2	$TB_{b_1}^{80 \text{ d.f.}}$	TB_{b_2}
1951	.3302	.457	46.0735	.0034	.1827	.4447	7.8035
1952	.3703	.130	201.1552	.0139	.0716	1.3986	2.7216
1953	.4604	.157	196.8754	.0108	.0907	.9742	3.1433
1954	.4604	.105	230.1527	.0147	.0671	1.1974	2.2841
1955	.4320	.111	221.9548	.0130	.0694	1.0368	2.4209
1956	.4870	.107	236.4623	.0140	.0746	1.0070	2.3009
1957	.4819	.073	253.0069	.0153	.0595	1.1175	1.8087
1958	.4603	.008	314.4194	.0191	.0062	1.3531	.1683
1959	.4557	-.003	341.6622	.0192	-.0113	1.2950	-.3313
1960	.4651	-.014	333.5122	.0142	.0027	.7696	.0754
1961	.3851	-.008	310.6831	.0154	.0120	.9177	.3307
1962	.3319	-.011	359.1792	.0156	-.0302	.8886	-.8669

Significance of Number of Food Stores and Per Capita Disposable Income

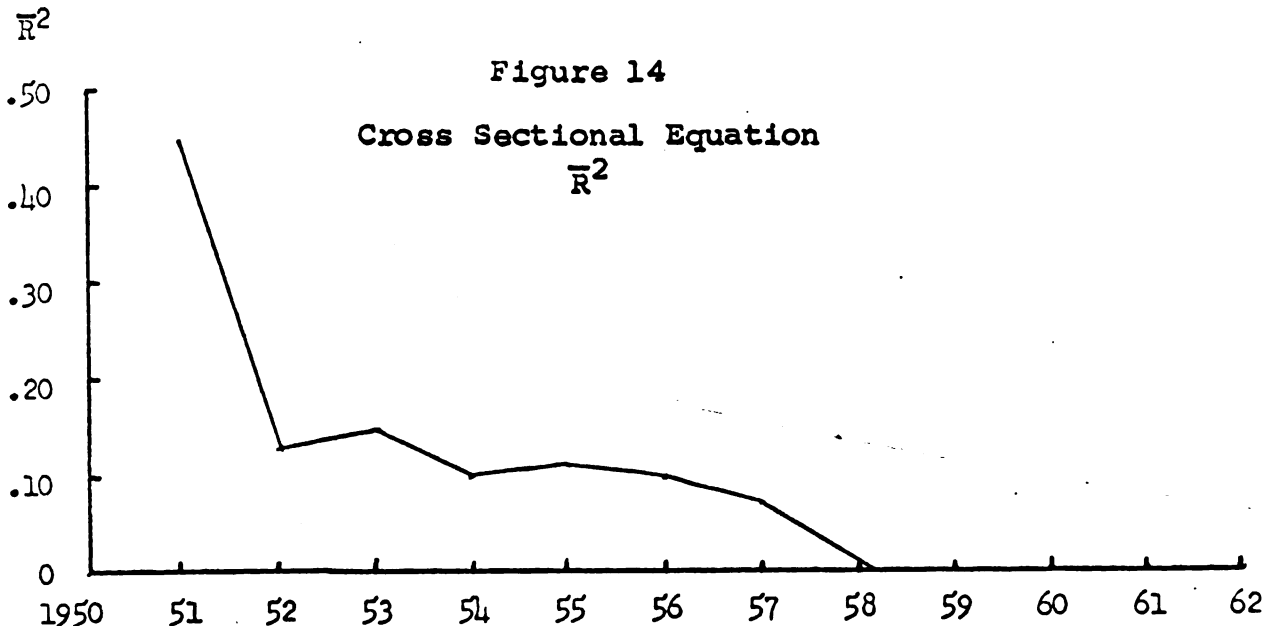
 (TB_{b_i}) 

State = .3705 = TB_{b1}
1.484 = TB_{b2}

The cross sectional analysis was conducted to determine what effect, if any, the number of food stores and per capita income level had on variations of gross sales among counties in a given year. Therefore, any discussion must be based on years rather than individual counties.

Intercorrelation over the 12-year period remained fairly constant, ranging from a low of .33 in 1951 to a high of .48 in 1956.

$\bar{R}^2$ followed a distinct trend over the 12-year period. In 1951, over 45% of the variation in gross sales between counties was explained by the two independent variables. However, immediately after the year 1951, $\bar{R}^2$ decreased to .13 and then slowly continued downward until after 1957 the two independent variables were found to explain little or none of the gross food sales among Michigan's counties. Figure 14 shows how after 1957 the equation loses all its ability to explain variations in the dependent variable.



No explanation of this trend is readily available. However, it may be attributed to:

- 1) An insignificant difference in per capita food sales among counties for a given year.
- 2) An insignificant difference in the number of food stores or per capita income among counties for a given year.
- 3) The two independent variables have no effect on the variation in gross food sales between counties during the 1957-62 period.
- 4) A combination of 1, 2, or 3, above.
- 5) Unknown factors.

Data used prove numbers 1 and 2 to be untrue in this particular study. Therefore, either number 3 is true and/or there are other factors, still unknown, which do effect these variations. Regardless, results for the years following 1957 must be interpreted as an explicit inability of the two independent variables to explain variations in gross sales among counties.

Table 17 shows both b_1 and b_2 to be positive throughout the 1951-57 period. The major fact worth noting, with regard to these results, is a positive b_2 which is also less than 1.0 and therefore, illustrates that Engel's Law does, indeed, hold true in Michigan under "static"¹ conditions. For example, in 1951, a " b_2 " of .19 indicates that people in County A,

¹Static refers to changes during a 1-year period since data used are average over a year.

receiving a \$1. higher per capita disposable income than the people in County B, will spend \$.18 more on per capita food expenditures than those people in County B. Therefore, if the people in both counties were originally spending 33% of their disposable income on food, the higher income people in County A now spend a lower percent of their income on food than do the people in County B. In essence, Engel's Law would, indeed, apply to the state of Michigan under static conditions.

Tb_{b_1} and Tb_{b_2} vary among the years 1951-57, however, deflated per capita disposable income is more significant than the number of food stores in each of the seven years.

Simple Curvilinear Regression Equation Coefficient Estimates:

The following two equations were used to project the values of the two independent variables, number of food stores (x_4) and per capita disposable income (x_5).

$$I: x_4 = a_1 + b_{41} x_T + b_{42} x_T^2$$

$$II: x_5 = a_2 + b_{51} x_T + b_{52} x_T^2$$

In the simple projection of the values of the independent variables, Table 18 shows a $\bar{R}^2$ ranging from .239 (per capita income) for Baraga County to .996 (number of food stores) for Wayne County. Generally, $\bar{R}^2$'s were .600 or higher, indicating that changes in number of food stores or income levels tend to move in close approximation with time.

Table 19. Simple Curvilinear Projection Equation for Income Level and Number of Food Stores.

County	Variable*	R^2	a	b_1	b_2	$\frac{9 \text{ d.f.}}{Tb_1}$	Tb_2
Baraga	I	.834	91.5339	-2.1880	.0144	1.9668	.7173
	II	.239	28520.9570	-993.1213	8.9850	-1.8413	1.8798
Benzie	I	.992	940.4102	-15.8832	.0720	-2.0013	1.0661
	II	.953	13472.2333	-468.7750	4.5762	-4.0187	4.4347
Ingham	I	.965	1213.9961	-24.5228	.1456	-1.4349	.9632
	II	.742	-11537.7656	437.3574	-3.4815	1.5132	-1.3616
Missaukee	I	.368	151.6450	-4.5118	.0380	-1.4173	1.3486
	II	.733	74.1602	-.7050	.3174	-.0031	.1565
Wayne	I	.996	21504.5313	-367.6108	1.4143	-2.4553	1.0634
	II	.643	-18676.9609	702.7620	-5.9161	2.3164	-2.2043
State	I	.617	-13335.5469	495.2266	3.8446	.9782	-.8589
	II	.965	249.1592	-6.4433	.0722	-1.7624	2.2323

*I= number of food stores

II= per capita disposable income

Since time was used as the independent variable in these equations, the magnitude of b_1 or b_2 presents little information for economic discussion.

Again, the reader will notice a great deal of variation in Tb_1 among the five selected counties and the state.

Index Number Projections:

In order that the projected food sales and income level data could be properly deflated, both the food price (F.P.I.) and the consumer price index (C.P.I.) had to also be projected into a given year.

Equations used:

$$\text{III: } x_{\text{FPI}} = a_1 + b_{11}x_T + b_{12}x_T^2$$

$$\text{IV: } x_{\text{CPI}} = a_2 + b_{21}x_T + b_{22}x_T^2$$

Both F.P.I. and C.P.I. projections are applied to each of the 83 counties and the state.

Table 19. F.P.I. and C.P.I. Index Projection Equations.

Index	R^2	a	b_1	b_2	$\frac{9 \text{ d.f.}}{TS_{b_1}}$	$\frac{9 \text{ d.f.}}{TS_{b_2}}$
III (F.P.I.)	.766	418.3032	-11.7333	.1122	-2.0039	2.1652
IV (C.P.I.)	.965	249.1592	6.4438	.0722	-1.7624	2.2323

Generally speaking, all of the equation results presented in Table 19 indicate that the projection lines fairly accurately depict the trends of both indexes over time. The results of projections are presented in Table 20, Figure 12 and Figure 13. The reader should not fail to note the use of 1950 as the base period. Therefore, all food sales and income data are deflated to reflect changes in both the physical volume of food and the real purchasing power of per capita income as compared to relationships existing in 1950.

Table 20. C.P.I. & F.P.I. Index Projections.

F.P.I.	C.P.I.
1950 - 100.0	1950 - 100.0
1951 - 111.3	1951 - 108.0
1952 - 113.3	1952 - 110.4
1953 - 111.6	1953 - 111.2
1954 - 111.3	1954 - 111.7
1955 - 109.7	1955 - 111.3
1956 - 110.5	1956 - 113.0
1957 - 114.1	1957 - 117.0
1958 - 118.9	1958 - 120.2
1959 - 117.0	1959 - 121.1
1960 - 118.3	1960 - 123.0
1961 - 119.7	1961 - 124.3
1962 - 120.8	1962 - 126.7
1965 - 128.8	1965 - 134.5
1970 - 145.7	1970 - 150.9
1975 - 168.3	1975 - 170.9
1980 - 196.4	1980 - 194.4

Simple Curvilinear Projection of Retail Food Sales:

In order to compare the composite method of projection, used in this paper, with the simple projection over time, the following equation was also calculated.

Figure 12
Food Price Index Projections

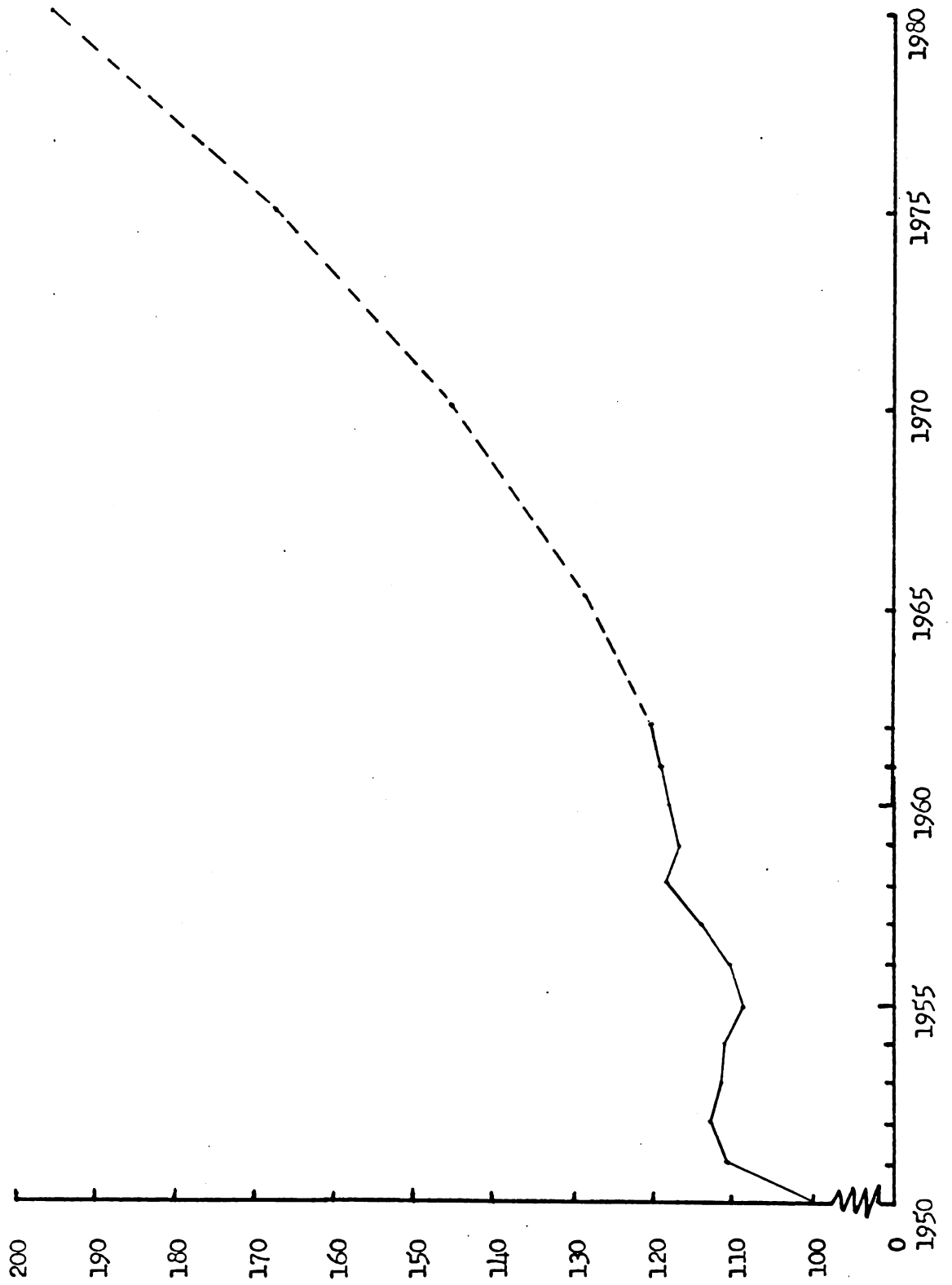


Figure 12
Food Price Index Projections

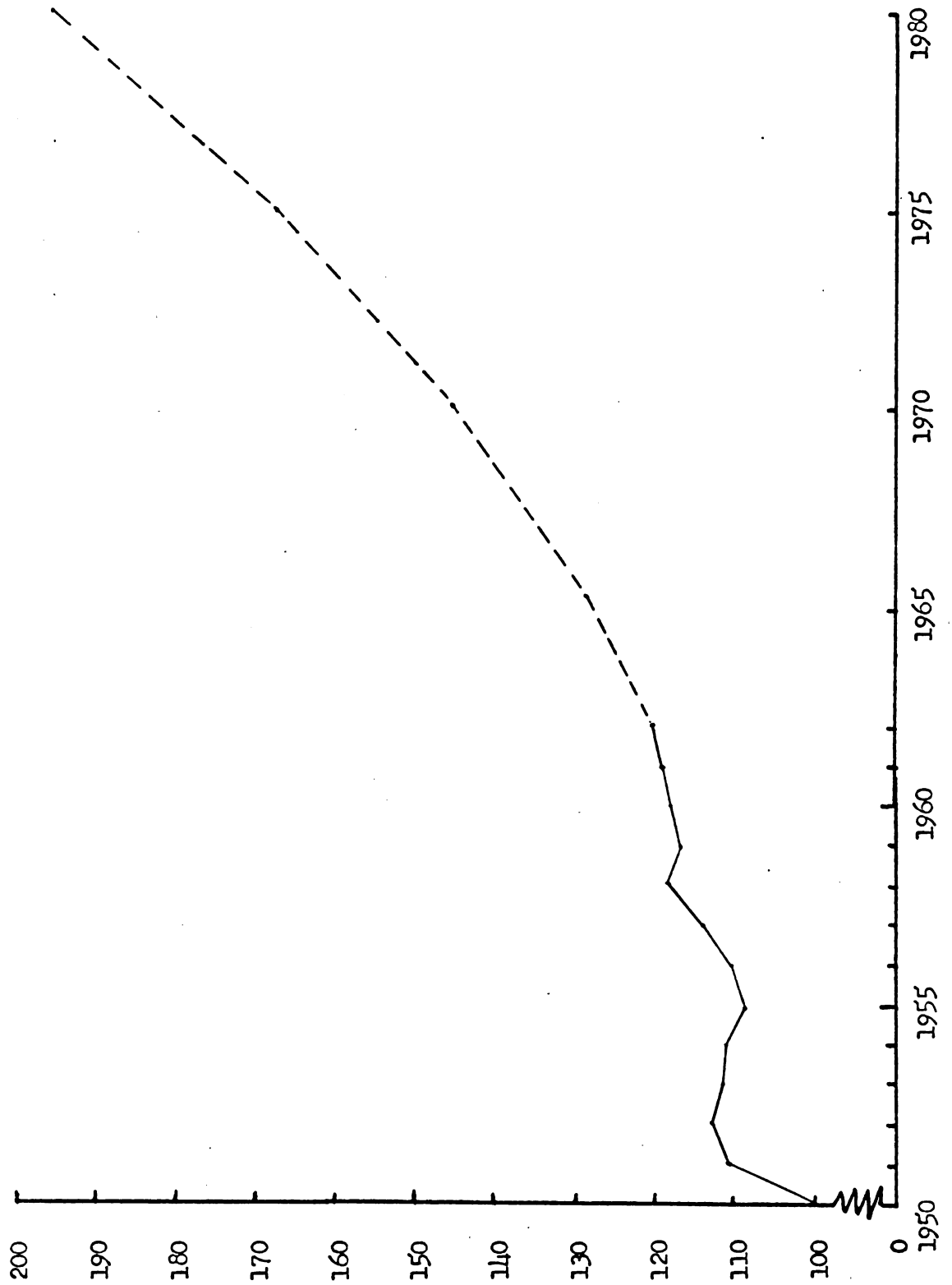


Figure 12
Food Price Index Projections

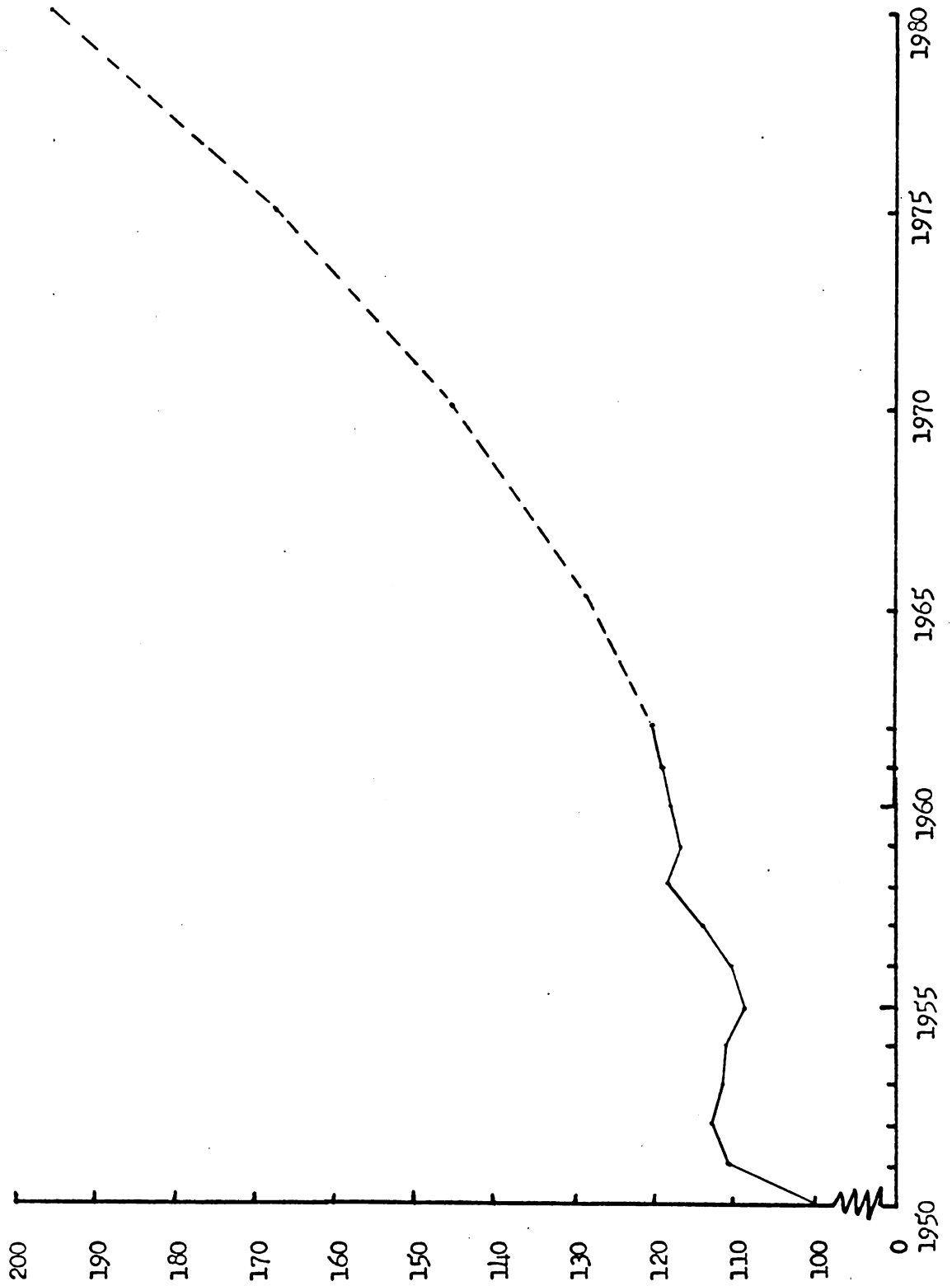
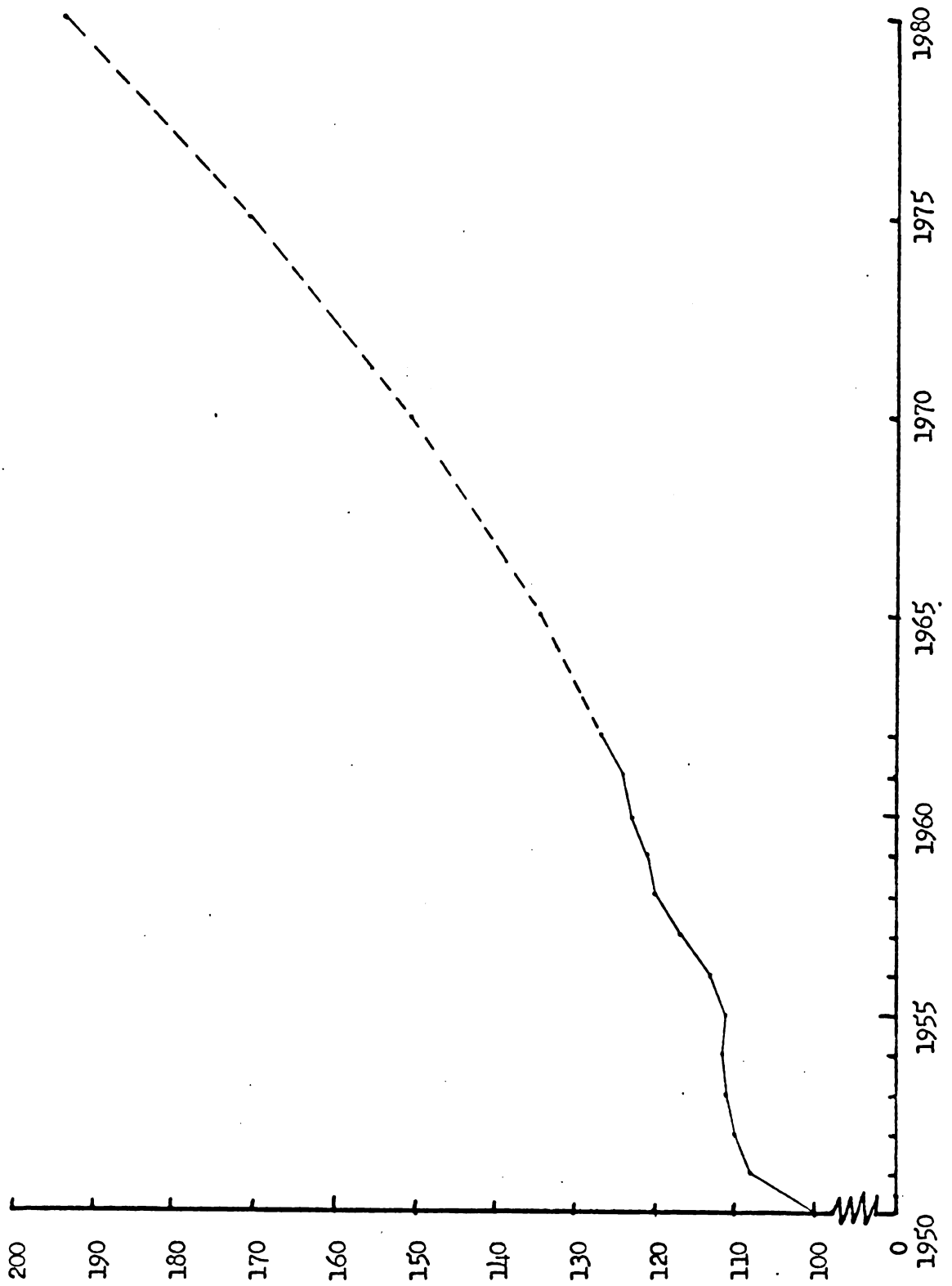


Figure 13
Consumer Price Index Projections



$$V: x_{FS} = a + b_1 x_T + b_2 x_T^2$$

Table 21. Simple Curvilinear Projection Equation for Gross Retail Food Sales.

County	Code #	$\bar{R}^2$	a	b_1	b_2	$\frac{9 \text{ d.f.}}{TB_{b_1}}$	TB_{b_2}
Baraga	7	.915	14191976.	494919.	4959.1	2.1867	2.4768
Barren	11	.967	-215834368.	7772672.	-51066.3	1.8806	-1.3967
Ingham	33	.980	-519491480.	18515328.	-137645.8	3.9166	-3.2914
Missaukee	57	.815	-19472356.	688394.4	-5653.9	2.5201	-2.3399
Wayne*	62	.898	-13042.5	490.8	-4.2	6.6530	-6.4513
State*	84	.999	6728224.	-132784.	2530.5	-2.1576	4.6478

*Food sales data had been reduced by (\$000,000)

Data in Table 21 was used to compare the Composite method of projection of food sales used in this paper with the commonly used simple curvilinear projection technique. This simple projection technique is often used to project data using time as the independent variable and making no effort to determine what factors effect these changes over time. This method was first used in this paper to project the values of the independent variables later used in the Composite method. Again, data in Table 21, tend to indicate that the projection lines fit quite well to the food sales data of the 12-year period. However, this projection cannot be judged until it is compared with the

Composite method being tested in this paper.

Population Projection Results:

In order to convert per capita data into total per county projections, the county population was also projected, using a simple geometric linear expansion. The results are shown in Table 22.

A simple curvilinear regression equation was not used to project the county and state population data to the year 1980. Following a discussion with Dr. John F. Thaden, a demographer at Michigan State University, it was decided not to use a regression equation since the exponential term, generally used, would tend to increase population data beyond reasonable limits. The well-known geometric tendency of population growth makes this type projection seem more reasonable with the population variable than with the other variables.

Geometric Linear Projection - This procedure involves the calculation of each county's average annual percent increase (or decrease) in population over the 12 year period 1951-62.

Projections are made using the following equations:

$$\begin{array}{rcl}
 \text{Population}_{1,1963} & =d_1 \cdot & \text{Population}_{1,1962} \\
 \text{Population}_{1,1964} & =d_1 \cdot & \text{Population}_{1,1963} \\
 \vdots & & \vdots \\
 \vdots & & \vdots \\
 \vdots & & \vdots \\
 \text{Population}_{1,1980} & =d_1 \cdot & \text{Population}_{1,1979}
 \end{array}$$

Table 22. Michigan County Population.

(000)						
Year	Baraga	Benzie	Ingham	Missaukee	Wayne	State
1951	7,948	119.1	176.8	7,391	2458.3	6516.9
1952	7,860	122.5	180.6	7,323	2481.4	6662.1
1953	7,771	126.0	187.4	7,256	2504.5	6809.2
1954	7,633	129.4	188.3	7,188	2527.7	6952.3
1955	7,594	132.8	192.1	7,121	2550.8	7097.5
1956	7,505	136.2	195.9	7,054	2573.9	7243.6
1957	7,417	139.6	199.8	6,986	2596.9	7387.8
1958	7,328	143.0	203.6	6,919	2620.1	7532.9
1959	7,240	146.4	207.5	6,851	2643.2	7678.1
1960	7,151	149.9	211.3	6,784	2666.3	7823.2
1961	7,072	154.3	215.9	6,722	2691.6	8038.4
1962	6,994	158.8	220.8	6,661	2717.2	8265.9
1965	6,764	173.3	235.8	6,482	2795.3	9033.9
1970	6,398	200.4	263.2	6,193	2930.7	10683.8
1975	6,061	231.8	298.7	5,917	3072.6	13016.6
1980	5,723	268.0	327.8	5,653	3221.2	16435.4

Where: i = counties #1-83

d = average annual percent increase (or decrease)
in population

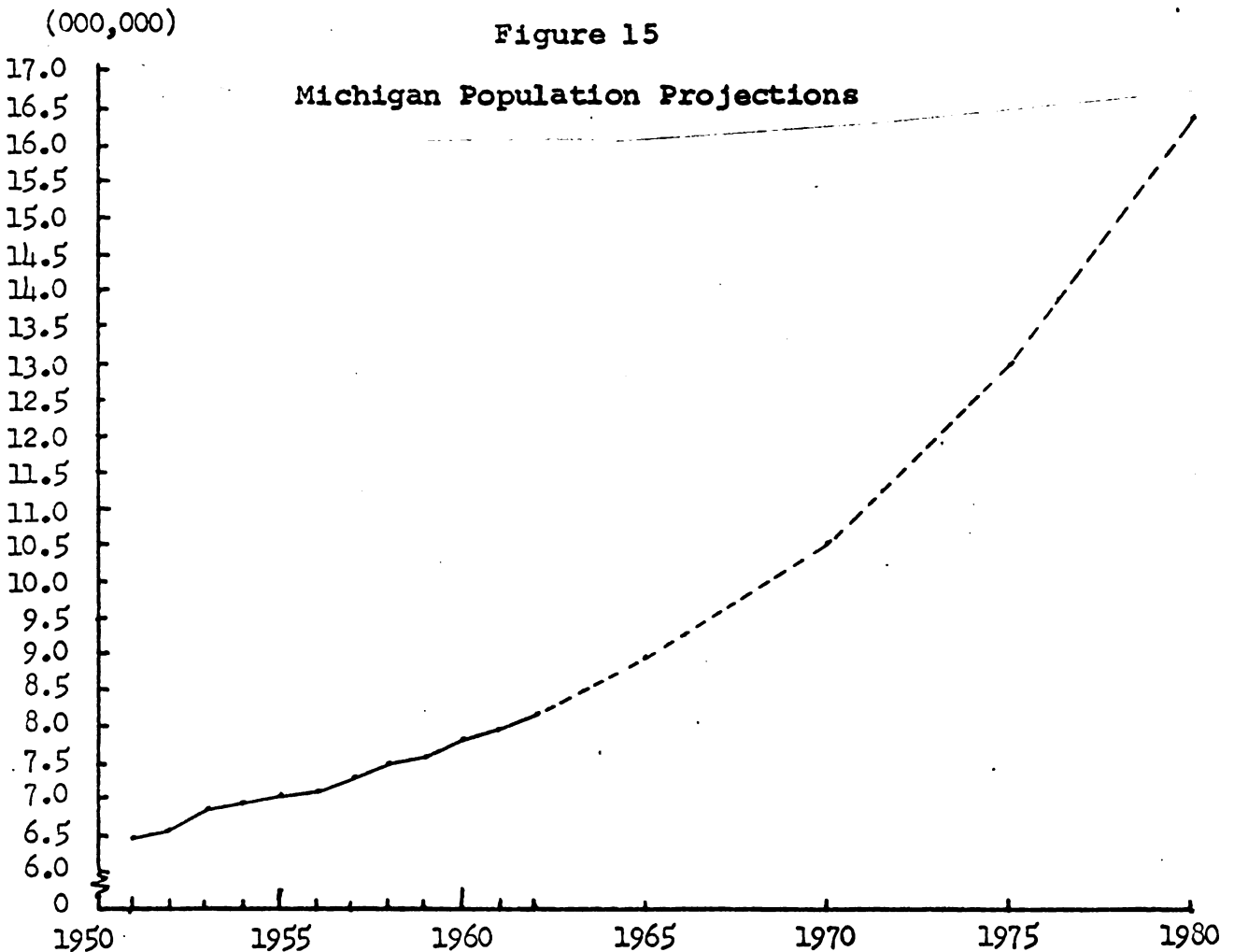
The major advantage of this technique is that it represents the true geometric tendency of population growth while

also taking into consideration those counties decreasing in population.

Its major disadvantage is that it does not explicitly take into account the effect of in- and out-migration on a county's population growth and also assumes that those counties losing population, do so in geometric fashion - which is not necessarily so.

Dr. Thaden suggested the use of the Geometric Linear projection, assuming its accuracy to be sufficient for the purpose of this particular project.

Figure 15 illustrates this geometric expansion in Michigan's population.



Statistical Significance:

In analyzing the importance of the T_{b_1} values presented in all the equations, the following table is given so that statistical significance can be measured at various levels of probability.

Note: Regression coefficient is statistically significant if $t(\frac{1}{2}\alpha, df) < T_{b_1} < t(\frac{1}{2}\alpha, df)$

Table 23. (two-tailed) t-value Statistical Table.

$\frac{\alpha}{2}$	.01	.02	.05	.10	.20	.4
9	3.250	2.821	2.262	1.833	1.383	.803
80	2.646	2.380	1.993	1.667	1.294	.847

Here, again, it is purposely pointed out that the term "statistically significant" is often confused with regard to the context in which they are found. Likewise, the selection of an α level, at which the significance is tested, may also be misleading. For example, by selecting a .05 level for α , one is specifying that he wants only a five percent chance of rejecting a factor as having a significant effect on the dependent variable, when in fact, it does (committing a Type I error). This selection cannot be arbitrary, but must be made in due respect to the probability of a Type II error and minimization of the expected loss function.

CHAPTER VII

PROJECTION PROCEDURE

Now that coefficient estimates have been presented and explained, the final step remaining is the use of the results in the actual projection of potential gross retail food sales. So as not to burden the reader with a complicated description of the projection procedure, one county has been selected (Berrien) to be used in a sample demonstration. A complete and detailed projection of potential gross retail food sales in 1965 will be made for Berrien County and each step will be discussed so that the reader will understand the procedure as well as the correct use of the estimates presented in Chapter VI.

Potential Gross Retail Food Sales - Berrien County 1965

Step 1: Projected Food Price Index 1965

The first step is the calculation of the estimated food price index for this year. This involves the use of the simple curvilinear equation and the test results presented in Table 19 of Chapter VI. Since this index will be applied to all counties, the subscript "1" represents counties 1-83 and state for the year 1965.

$$X_{FPI} = a_1 + b_{11}x_T + b_{21}x_T^2 \quad (X_{FPI} = x_2)$$
$$FPI_{1,1965} = 418.3032 - 11.7335x_T + .1122x_T^2$$

$$= 418.3032 - 11.7335(65) = .1122(4225)$$

$$= 418.3032 - 762.6775 + 474.0450$$

$$= 129.6707$$

Step 2: Projected Consumer Price Index

This step is similar to Step 1 in that it involves the calculation of an estimated index number for the year 1965. Here, also, the index number is applied to all 83 counties and thereby need not be calculated for each individual county. Test results are also found in Table 19 and results of the calculations of both food price and consumer price index for the years 1965, 70, 75 and 80 are found in Table 20.

$$X_{CPI} = a_2 + b_{12}X_T + b_{22}X_T^2 \quad (X_{CPI}) = x_6$$

$$\begin{aligned} CPI_{1,1965} &= 249.1592 - 6.4438X_T + .0722X_T^2 \\ &= 249.1592 - 6.4438(65) + .0722(4225) \\ &= 249.1592 - 418.8470 + 305.0450 \\ &= 135.3572 \end{aligned}$$

Step 3: Projected Number of Food Stores in Berrien County 1965

Test results from Table 18 are now used to estimate the number of food stores (x_4) that will exist in Berrien County (Code Number 11) in 1965. In this equation x_4 is the dependent variable, however, once the estimated value is determined, it will then be used as one of the two selected independent variables of the multiple linear projection equation.

$$x_{4pq} = a_1 + b_{1pq}X_{Tzq} + b_{2pq}X_{Tzq}^2 \quad \begin{array}{l} z = \text{county \#} \\ q = \text{year} \end{array}$$

$$\begin{aligned}
 *PS_{11,1965} &= 940.4102 - 15.8832x_T + .0720x_T^2 \\
 &= 940.4102 - 15.8832(65) + .0720(4225) \\
 &= 940.4102 - 1032.4080 + 304.2000 \\
 &= 212.2022
 \end{aligned}$$

Step 4: Projected Per Capita Disposable Income in Berrien County 1965

Here, also, a simple curvilinear equation is used to determine the estimated per capita disposable income (x_5) in Berrien County in 1965. Test results presented in Table 18 are used to calculate this estimate which later becomes part of the second independent variable of the multiple linear projection equation.

$$x_{5zq} = a_2 + b_{1zq}x_{Tzq} + b_{2zq}x_{Tzq}^2$$

$$\begin{aligned}
 PCDI_{11,1965} &= 13472.2383 - 468.7750x_T + 4.5762x_T^2 \\
 &= 13472.2383 - 468.7750(65) + 4.5762(4225) \\
 &= 13472.2383 - 30470.3750 + 19334.4450 \\
 &= \$2336.31
 \end{aligned}$$

Step 5: Projected Deflated Per Capita Disposable Income in Berrien County 1965

Before this estimated value of per capita disposable income (x_5) can be used as an independent variable in the final projection equation, it must be deflated by the estimated consumer price index in 1965 to render it more representative of its true purchasing power (as compared to the base period 1950).

$$DFCDI_{11,1965} = \left(\frac{x_5}{x_6} \right) 100$$

$$\begin{aligned}
 \text{DPCDI}_{11,1965} &= \left(\frac{\text{PCDI}_{11,1965}}{\text{CPI}_{1,1965}} \right) 100 \\
 &= \left(\frac{12336}{135} \right) 100 \\
 &= \$1,730.
 \end{aligned}$$

**Step 6: Projected Deflated Per Capita Gross Retail Food Sales
in Berrien County 1965**

Now that steps 3, 4, and 5 have been completed, the estimated values of the two independent variables ($\#FS_{11,1965}$ and $\text{DPCDI}_{11,1965}$) can be placed into the multiple linear projection equation and the potential deflated per capita gross retail food sales $\left\{ 100 \left[\frac{\begin{pmatrix} x_1 \\ x_3 \end{pmatrix}}{x_2} \right]_{11,1965} \right\}$ determined for Berrien County in 1965. The coefficients for this calculation are found in Table 16.

$$100 \frac{x_1}{x_2} zq = a + b_1 x_4 zq + b_2 zq \left(100 \frac{x_5}{x_6} zq \right)$$

$$100 \frac{x_1}{x_2}_{11,1965} = a + b_1 \#FS_{11,1965} + b_2 \text{DPCDI}_{11,1965}$$

$$\begin{aligned}
 \text{DPGGRFS}_{11,1965} &= a + b_1 \#FS_{11,1965} + b_2 \text{DPCDI}_{11,1965} \\
 &= 652.4422 + .3563 \#FS_{11,1965} + .1268 \text{DPCDI}_{11,1965} \\
 &= 652.4422 + .3563(212) + .1268(1730) \\
 &= 652.4422 + 75.5356 + 219.3640 \\
 &= \$357.5428
 \end{aligned}$$

**Step 7: Projected Per Capita Gross Retail Food Sales in
Berrien County 1965**

If the reader is particularly interested in the non-deflated value of potential per capita gross retail food sales, the following procedure is followed.

$$\begin{aligned} \text{PGGRFS}_{11,1965} &= \text{DPGGRFS}_{11,1965} \cdot \text{FPI}_{1,1965} \\ &= 357.5426 \cdot 129.6707 \\ &= \$460.53 \end{aligned}$$

Step 8: Projected Deflated Total Gross Retail Food Sales in Berrien County 1965

This step involves the transformation of potential deflated per capita gross retail food sales ($\text{DPGGRFS}_{11,1965}$) into potential deflated total gross retail food sales for Berrien County in 1965 ($\text{DTGRFS}_{11,1965}$). This is a rather simple process in which the per capita datum is multiplied by the estimated 1965 Berrien County population ($\text{E.Pop.}_{11,1965}$) to derive the total county potential. The population estimation procedure was described in Chapter VI and projection results of the five selected counties and remaining 78 counties can be found in Table 22 (Chapter VI) and Appendix A, respectively.

$$\begin{aligned} \text{DTGRFS}_{11,1965} &= \text{DPGGRFS}_{11,1965} \cdot \text{E.Pop.}_{11,1965} \\ &= \$357.54 \cdot 173311 \\ &= \$61963614.94 \end{aligned}$$

Step 9: Projected Total Gross Retail Food Sales in Berrien County 1965

Again, just as in step 7, the deflated data can be changed to a non-deflated estimate by using the following procedure.

$$\begin{aligned} \text{TGRFS}_{11,1965} &= \text{DTGRFS}_{11,1965} \cdot \text{FPI}_{1,1965} \\ &= \$61965614.94 \cdot 129.6707 \\ &= \$79935642.06 \end{aligned}$$

The above nine steps shall hereby be referred to as the Composite Method of Determining Potential Retail Food Sales. This method can now be compared with a previously used and commonly accepted method. The method, to be compared with the Composite Method, is the simple curvilinear projection of food sales over time. This equation is of the commonly used form:

$$X_{FS} = a + b_1 X_T + b_2 X_T^2$$

The results of the calculations of data on the five selected counties are shown in Table 21. Although this method does not take into account the effects of any independent variables, as does the Composite Method, it is the only technique commonly used in making projections of this nature. Therefore, this technique shall also be used to project potential deflated and non-deflated total gross retail food sales for Berrien County in 1965, and the results compared with those of the Composite Method.

Step 10: Simple Projected Value of Gross Retail Food Sales
in Berrien County 1965

$$X_{FS} = a + b_1 X_T + b_2 X_T^2$$

$$\begin{aligned} SPVGRFS_{11,1965} &= +215834368. + 7772672.X_T - 51066.3125X_T^2 \\ &= -215834368. + 7772672.(65) - 51066.3125(4225) \\ &= -215834368. + 505223680. - 215755170. \\ &= \$73634142. \end{aligned}$$

**Step 11: Simple Projected Value of Gross Retail Food Sales
in Berrien County 1965 (deflated)**

Just as in the Composite Method, this datum is now deflated by the food price index so that it will be more representative of the true physical volume of food involved, as compared to a base year of 1960.

$$\begin{aligned} SPDVGRFS_{11,1965} &= \frac{SPVGRFS_{11,1965}}{FPI_{11,1965}} 100 \\ &= \left(\frac{73634142}{129.6707} \right) 100 \\ &= \$57169000. \end{aligned}$$

**Step 12: Comparison of Composite and Simple Curvilinear
Regression Results**

This step can best be accomplished by plotting the results of both methods and then deciding which is more acceptable. This method is used later in this chapter.

Discussion of Projection Procedure

All twelve steps, previously described, are now repeated for the years 1970, 75 and 80. This must then be again repeated for each of the remaining 82 counties and the state as a whole. For the reader who is interested in one

specific county, the data necessary to complete the twelve step projection procedure is located as follows:

Projected FPI values = Table 20 Chapter VI

Projected CPI values = Table 20 Chapter VI

Simple Curvilinear Regression Equation Coefficients for:

(x_4) No. of Food Stores = Appendix D

(x_5) Disposable Per Capita Income = Appendix D

(X_{FS}) Compared Method of Gross

Sales Projection = Appendix D

Multiple Linear Regression Equation Coefficients for:

Final Projection Equation

(Composite Method) = Appendix B

For purposes of this paper, the potential deflated and non-deflated retail food sales were only calculated for the five selected counties. Nevertheless, this provides sufficient information so that the Composite Method may now be compared with the simple curvilinear regression method and its relative value thereby determined.

County Discussion

Table 24 presents the projections of the deflated and non-deflated retail food sales for the five selected counties and state as a whole, derived from the Composite Projection Method. The deflated data is probably of more value to the food industry since it eliminates the misleading effect of price rises.

Table 24. Potential Retail Food Sales.

		(\$000)				
		County				
	Baraga	Missaukee	Berrien	Ingham	Wayne	State
1965						
Non-deflated	2,757	1,582	79,936	116,812	1,269,323	3,018,325
Deflated	2,137	1,226	61,966	90,552	983,971	2,339,787
1970						
Non-deflated	3,325	1,564	96,272	142,551	1,197,340	4,039,980
Deflated	2,278	1,071	65,940	97,633	820,596	2,767,110
1975						
Non-deflated	3,954	1,377	115,649	173,195	1,016,899	5,663,771
Deflated	2,354	819	68,839	103,092	605,297	3,371,292
1980						
Non-deflated	4,635	961	137,645	211,372	713,453	8,311,063
Deflated	2,365	491	70,227	107,843	364,009	4,240,338

Table 24 shows a projected decrease in potential gross retail food sales for Missaukee and Wayne counties, while Baraga, Berrien, and Ingham counties are shown to have an increasing potential retail food sales. There is also a large increase indicated in the state's potential. These Composite Projection results will now be compared with the simple curvilinear projections to show which technique proves to be most rational.

Berrien County - Figure 10 shows non-deflated gross retail food sales increasing over 50 percent between the years of 1962 and 1980. However, note how misleading this becomes when the inflationary effect of prices is removed. The deflated

potential seems to be leveling off, whereas the non-deflated potential continues to rise rather rapidly.

The simple curvilinear projection method shows non-deflated potential food sales leveling off at slightly less than 80 million dollars and deflated sales decreasing after 1965.

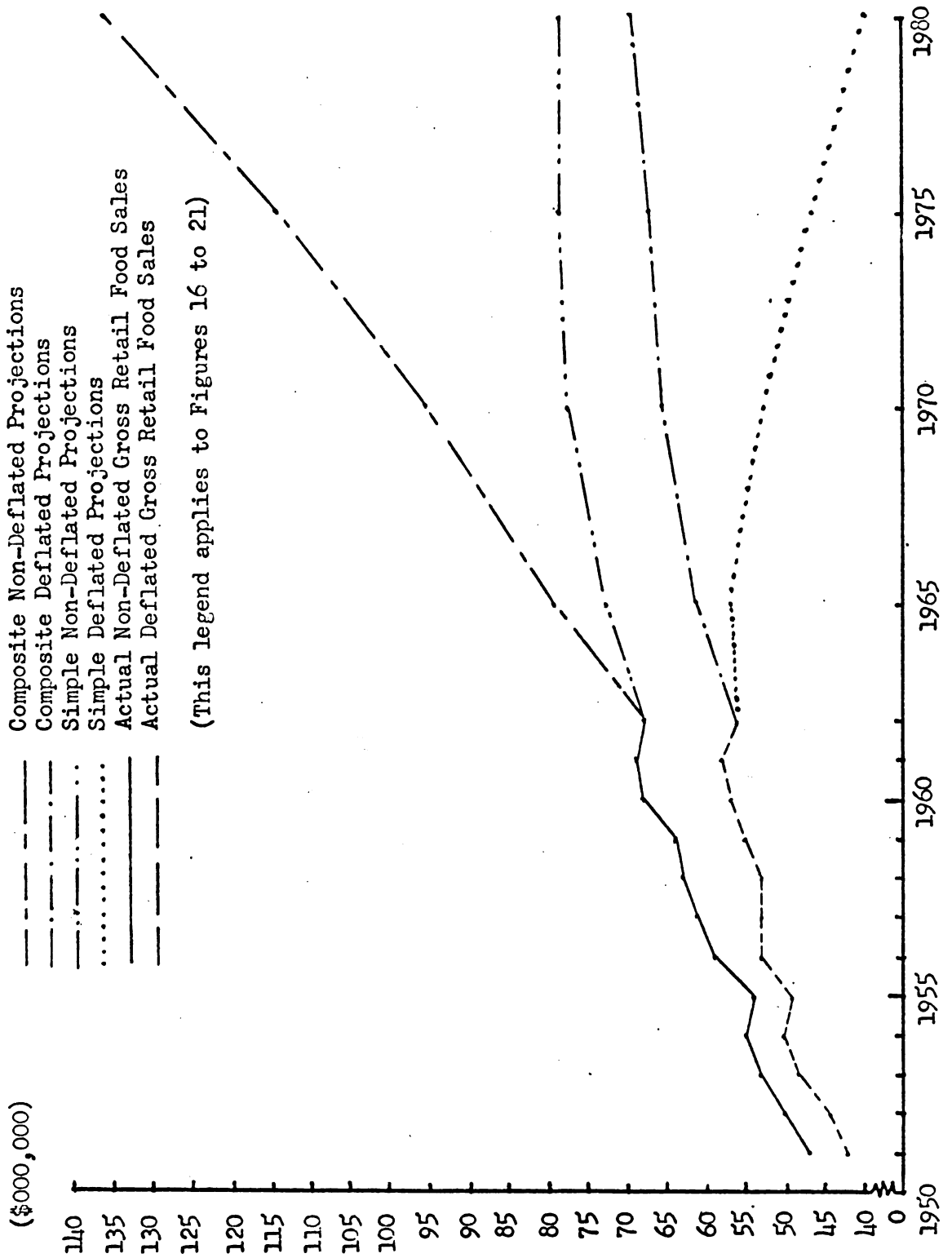
Since Berrien County is located in the southern portion of the state where population is continually increasing, one would expect food sales to increase in the future both in dollar value and physical volume. Therefore, the Composite Method seems to be more reasonable in its projection.

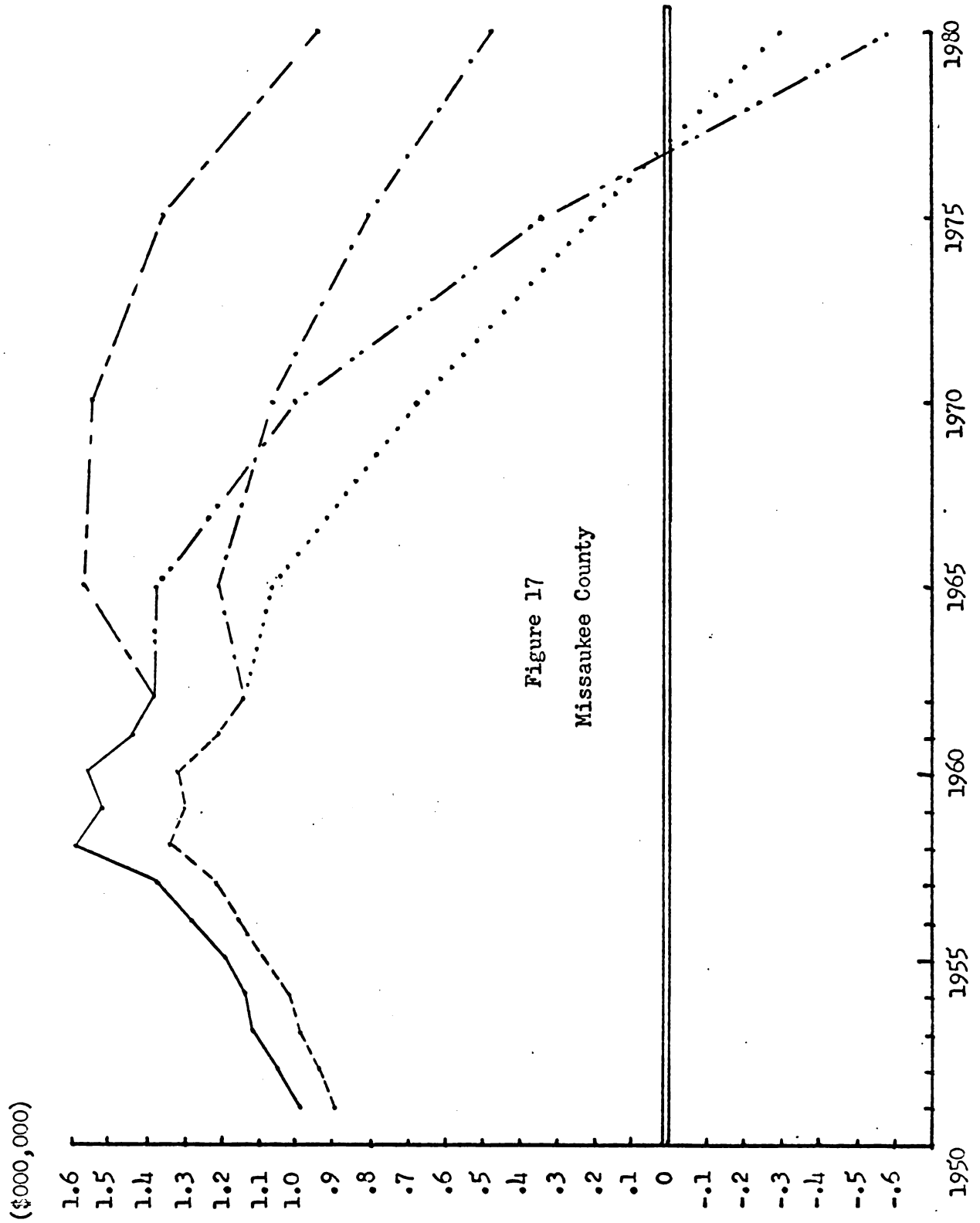
Missaukee County - In Figure 17, both methods show a general decrease in potential retail food sales. This decrease in future sales volume is not totally unexpected. Missaukee is a rural county with low per capita income level and a declining population in the twelve years of the observation period. However, again the Composite projection seems to be more realistic since the projected decrease is not as extensive as the simple curvilinear projection which is so inaccurate that it projects an impossible negative volume of sales for the years after 1975.

Ingham County - Figure 18 shows a distinctive difference between the two projection techniques. This difference proves to be a strong endorsement for the use of the Composite method. Ingham County has not only had a continuously growing

Figure 16

Berrien County





population, but also has one of the highest per capita income levels in the entire state. Continued urbanization, along with many other such trends, point towards an incessant increase in potential retail food sales. However, any retail food firm using the simple curvilinear method, would arrive at results showing an eventual decrease in both deflated and non-deflated potential food sales. Therefore, the composite method again seems to more accurately coincide with existing and expected conditions than does the simple method.

Wayne County - Figure 19 shows a decreasing potential volume of retail food sales and, again, is justifiable. Wayne County is not only the industrial center of Michigan, but is also the most heavily populated county. However, the tendency in the last two decades has been for a large portion of the people to move out of the city of Detroit and into the surrounding suburban areas. In response to this general movement of population, retail food stores have also moved out of the crowded downtown district and out into the surrounding areas. Many have located in the large number of shopping centers recently built in the suburban areas. Finding a retail food store in the downtown shopping district of Detroit is now almost as much an oddity as finding a "Cobo Hall" in a suburb like Farmington. As these retail outlets move out of the city of Detroit, they re-locate in the three surrounding counties of Oakland, Macomb and Washtenaw. Therefore, the decrease shown in Figure 19 does not represent a declining

Figure 18
Ingham County

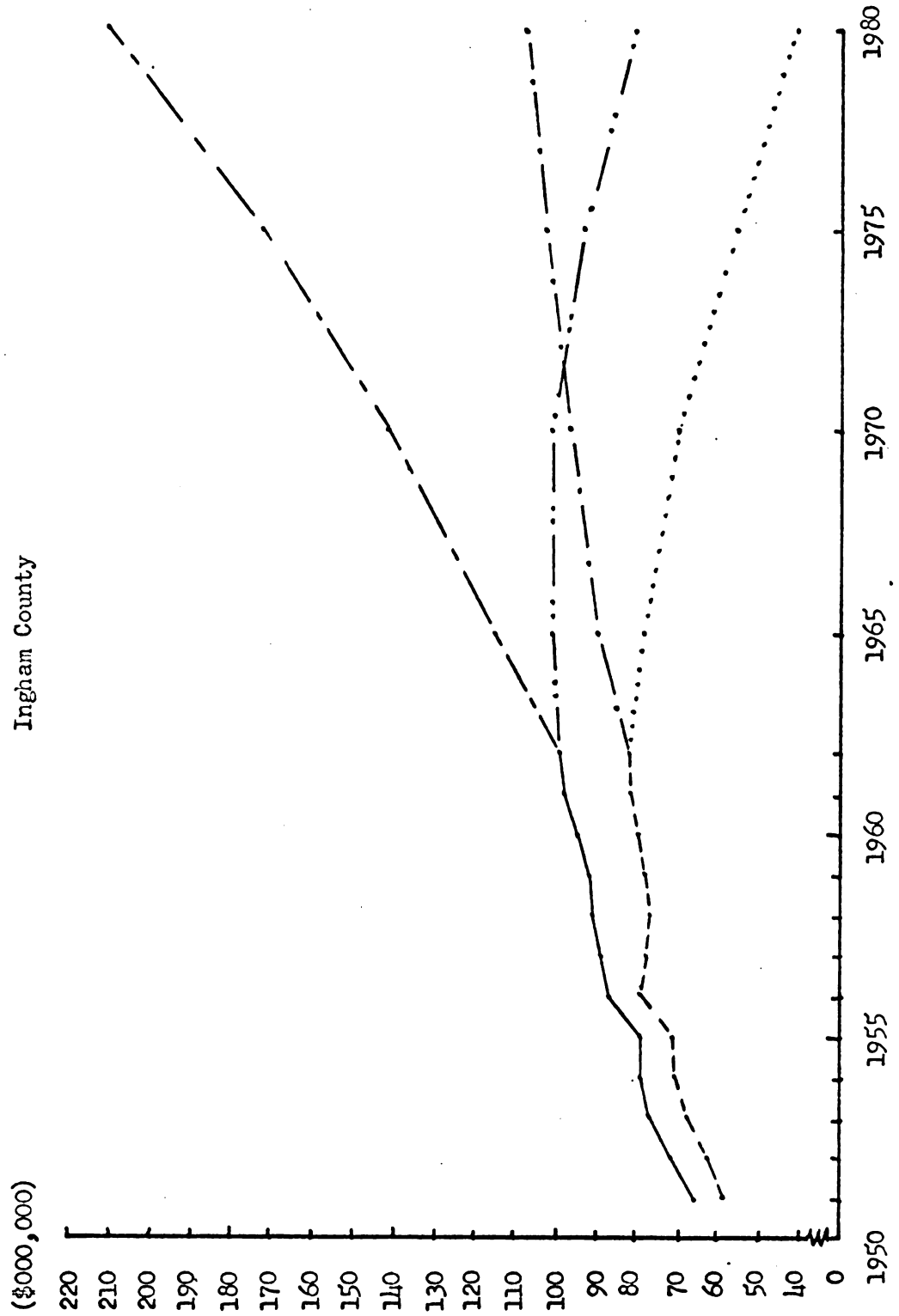
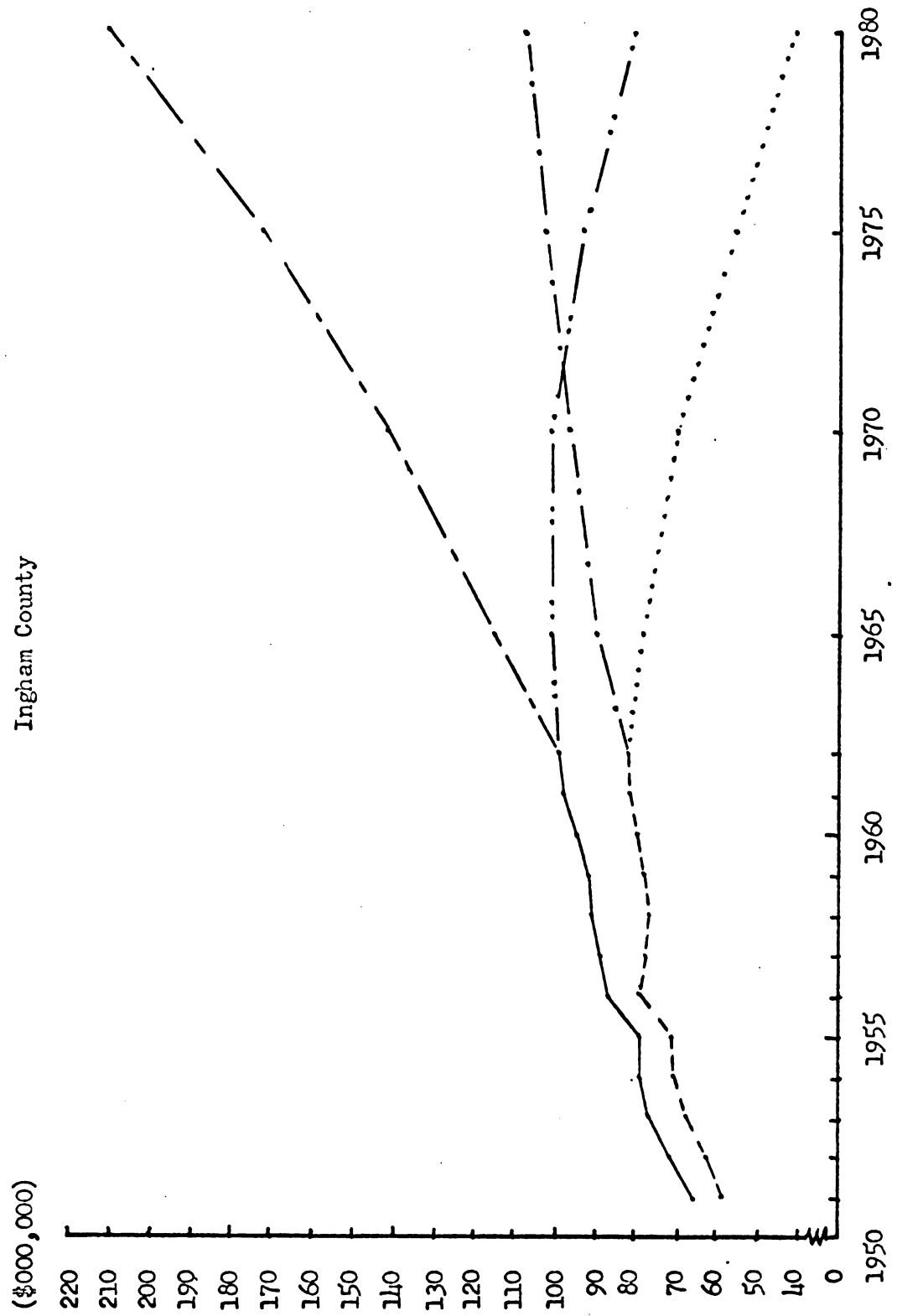
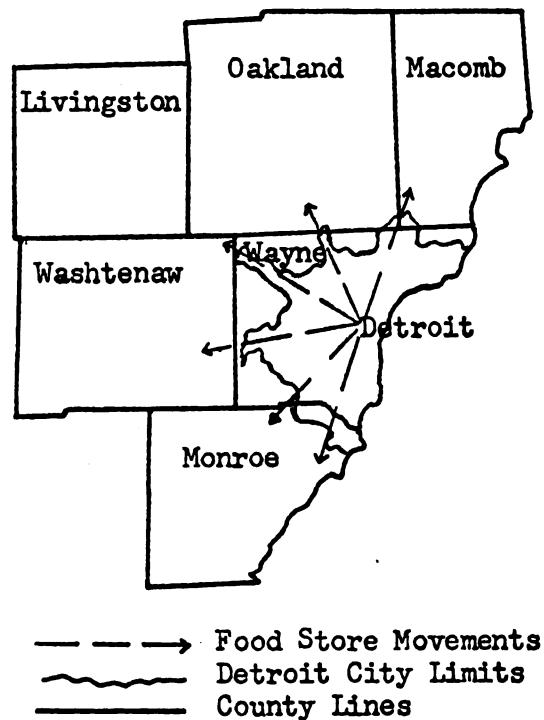


Figure 18
Ingham County

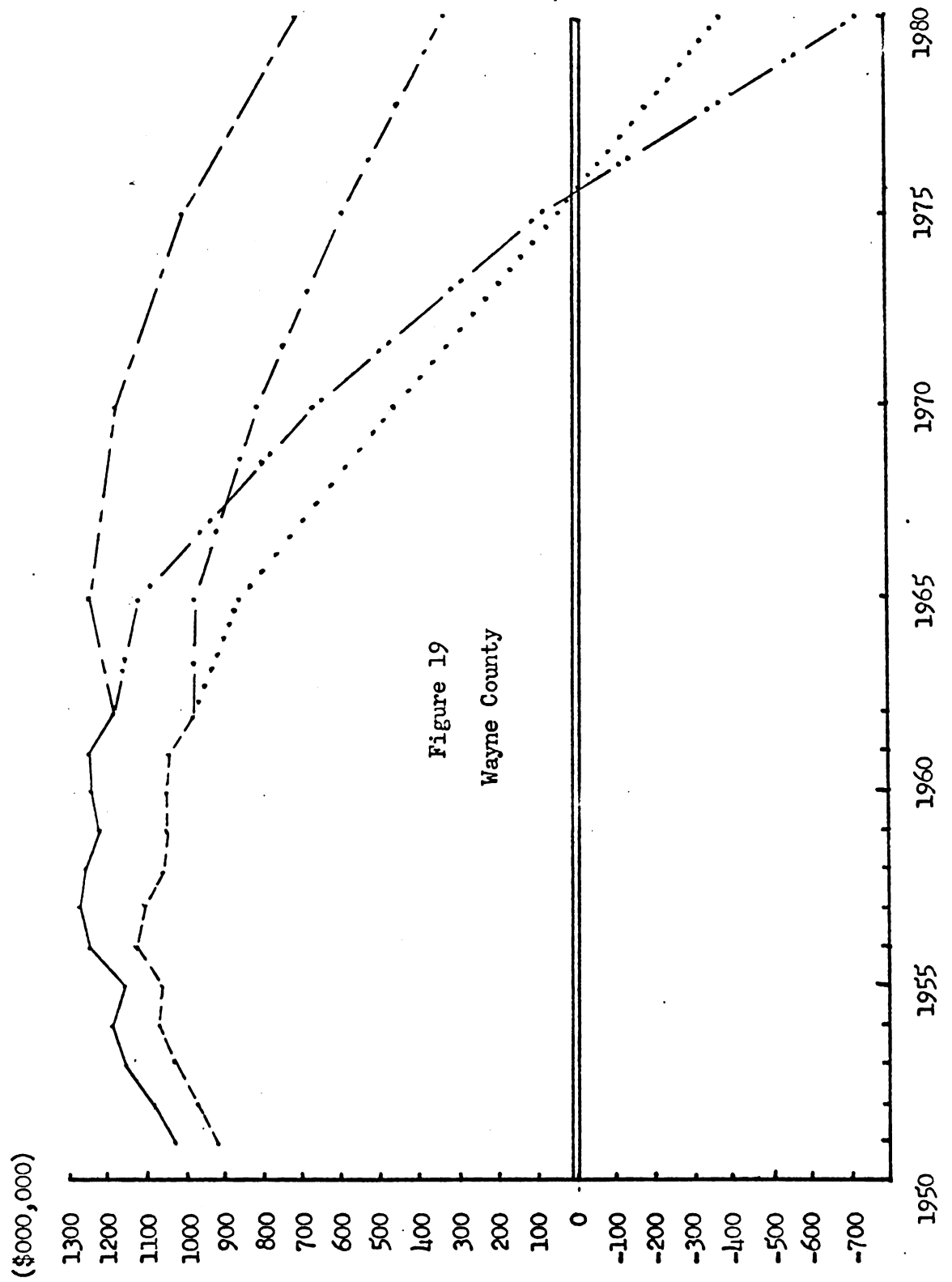


Detroit retail foodmarket, but rather a movement of this market out into the surrounding counties. Map #6 illustrates this movement.

Map #6
Detroit Area Counties



The Composite method, again, is a more realistic estimate, particularly on long run projections, since the simple projection technique shows a negative volume of potential retail food sales for the period following 1975. A decrease in the potential can be justified, but results like those derived from the simple projection are beyond any rationalization.



Baraga County - Baraga is the only upper peninsula county included in this five county analysis. Since this county has such a small resident population (approx. 6000), it is expected that the summer influx of tourists has a huge effect on its over-all economy. Likewise, it is expected that the annual volume of retail food sales is highly responsive to the number of "tourist days" each year. Figure 20 shows both deflated and non-deflated potential sales increasing, using the simple method. However, the Composite method shows only the non-deflated potential to be increasing to any extent. The deflated potential, which is more representative of the physical volume of sales, is shown to increase only slightly. This slight increase seems to be most easily justified because, despite the fact that tourism is expected to increase, the resident population is steadily decreasing. Thus, the Composite method is again more in accordance with anticipated conditions.

In each of the five selected counties, the Composite method of projection, described and used in this paper, has been shown to have a much more sound basis in economic logic. Even if the estimated values are not perfectly accurate, the Composite method can still be used with some degree of confidence by the retail food industry in comparing the counties' relative potentials for determining the most optimal area of expansion.

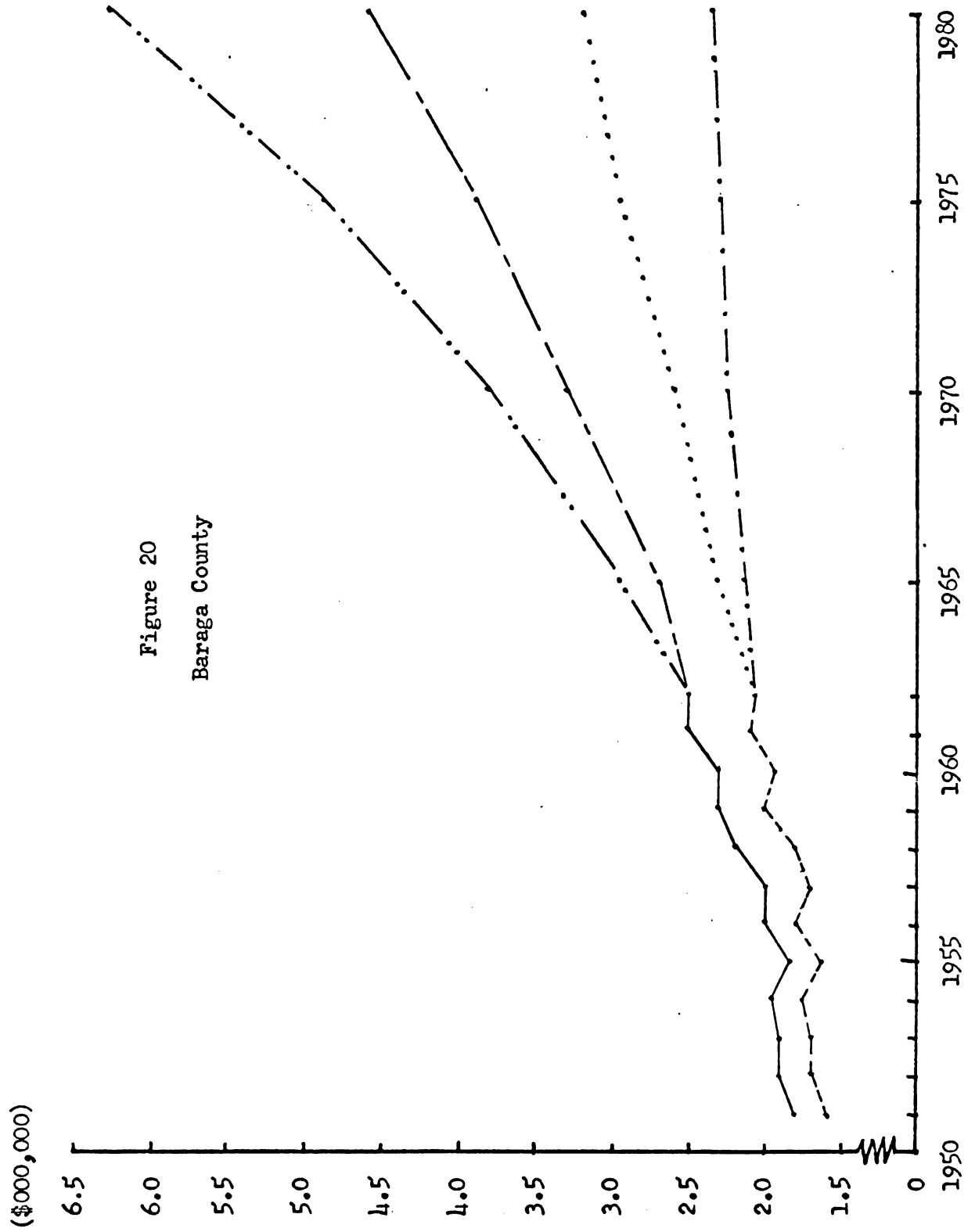
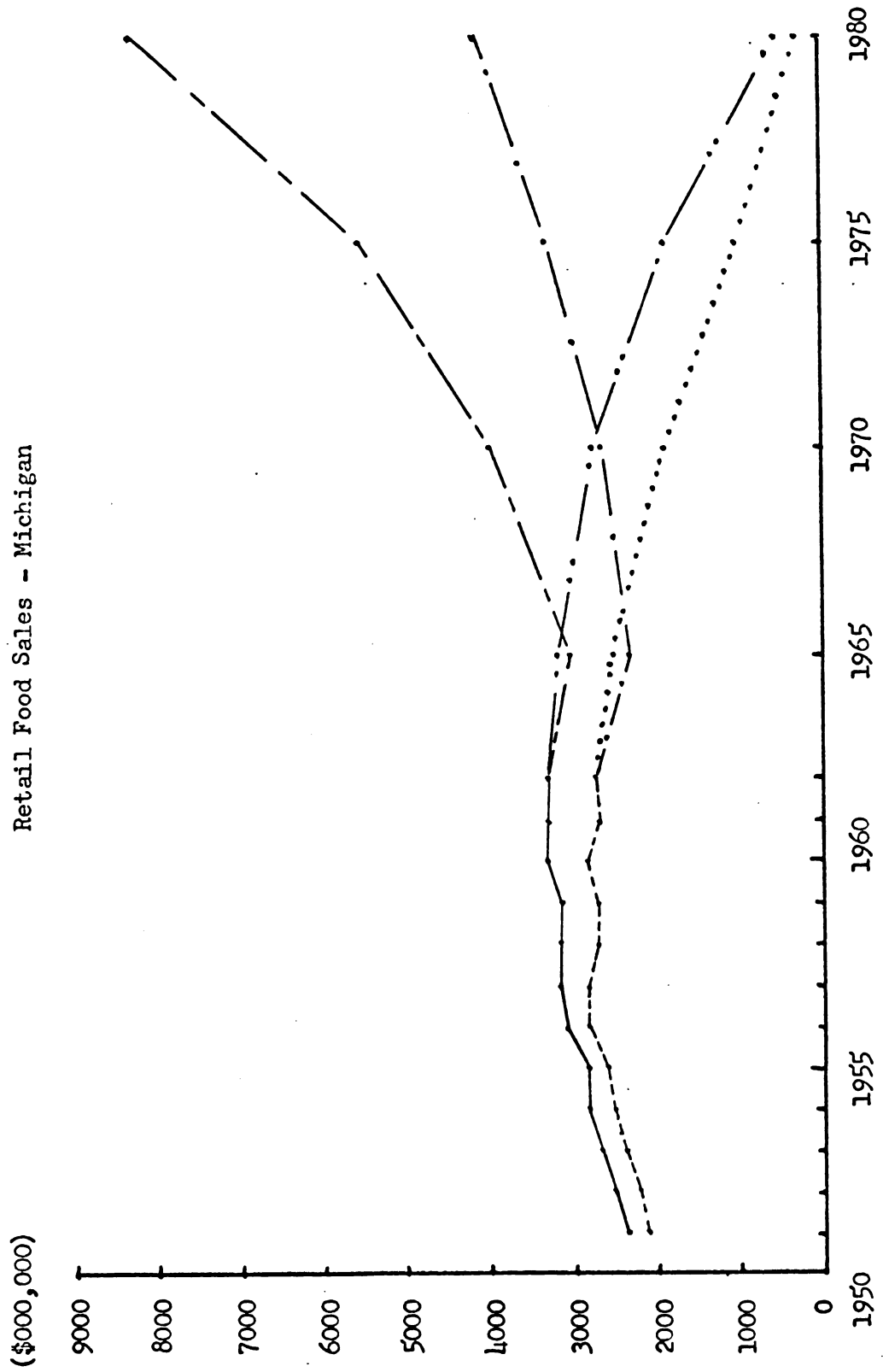


Figure 21
Retail Food Sales - Michigan



State - Of additional interest to the retail food industry is the potential sales of the state as a whole. As shown in Figure 21, the simple projection again presents an unrealistic future trend. Even if the physical volume of food sales in Michigan remained constant, general price rises would cause increases in future dollar volume of sales. Therefore, the decrease in both deflated and non-deflated potentials, derived from the simple curvilinear projection, is almost impossible to justify. However, the composite results indicate an increase in both the dollar and physical volume of future retail food sales. This can be justified by increasing population, income levels, urbanization, product availability, etc., which again endorses the Composite method.

Composition of Potential Sales Volume

The Composite Method of projection estimates that potential food sales in the state of Michigan will increase from 3.2 billion dollars in 1962 to 8.3 billion dollars in 1980. This 160 percent increase in food sales will occur to the food industry as a whole. Some importance is generally placed on an estimation of what proportion of the potential sales volume will occur in the various types of food stores. For purposes of this paper, the food industry has been divided into six general types of food stores. Figure 22 shows the percent of past annual total food sales which were reported by the six different types of food stores.

Figure 22

Percent of Total Food Sales Attributed to General Type of Food Store

Year	Food Store Type					
	Groceries	Dairy Products	Fruits & Vegetables	Restaurants (family)	Taverns & Clubs	Miscellaneous
1951	59.80	5.50	1.16	14.20	10.93	8.41
1952	60.78	5.64	1.11	13.37	10.77	8.37
1953	60.69	5.56	1.16	13.36	11.01	8.23
1954	61.43	5.42	1.02	13.17	10.83	8.07
1955	61.62	5.32	1.73	13.19	11.27	6.87
1956	62.36	5.13	1.51	13.11	11.14	6.74
1957	64.13	5.28	1.13	12.76	10.62	6.06
1958	65.92	4.96	.94	12.37	10.17	5.64
1959	66.72	4.66	.93	12.27	9.86	5.56
1960	66.51	4.40	.86	12.57	10.05	5.59
1961	68.14	4.38	.86	11.38	9.29	5.94
1962	68.38	4.05	.87	11.32	9.35	6.02

As might be expected, the percent of total retail food sales taking place in grocery stores has increased over the twelve year period while the dairy product, fruit and vegetable stores have become less important. This is due, of course, to a decrease in the number of small specialty food stores and a tendency for the grocery stores to swallow up their sales. If this trend continues, by 1980 almost 80 percent of total food sales will occur in grocery stores and less than 3 percent in specialty food stores.¹

¹Projections made using simple linear extrapolations based on twelve year trend.

It would normally be expected that the relative importance of food sales in restaurants had increased during the twelve year period. However, as shown in Figure 23, despite a 20 percent increase in the absolute volume of restaurant food sales,¹ the proportion of total food sales occurring in restaurants decreased from 14.2 to 11.3 percent during the observation period. Normally, as one's per capita income increases, one tends to eat a greater proportion of meals in restaurants. Therefore, restaurant food sales are not expected to drop below 10 percent of total retail food sales by 1980.

This unexpected drop in the relative importance of restaurant food sales may be partially justified by the trend towards increased consumption of ready prepared food which needs only to be heated before serving. Years ago, eating at a restaurant provided utility, in the form of convenience, as well as a social experience. But now, in the era of the "TV-Dinner," the convenience benefit has been somewhat eliminated. It now becomes just as convenient to put a TV dinner into the oven as to eat in a restaurant, and somewhat cheaper.

The slight decrease in the proportion of total food sales attributed to food sales in taverns may be the result of a decline in the number of taverns. Also, it may be the result of the average patron's increased thirst and decreased hunger? Nevertheless, the trend indicates a further drop to

¹K. D. Duft and Earl Brown, p. 18.

about five percent in 1980.

The remaining two percent of total 1980 retail food sales will be the result of sales in miscellaneous stores such as delicatessens, candy stores, etc.

Since Table 22 refers to the state as a whole, these proportions will vary among individual counties. For example, the tourist trade would tend to increase the relative importance of restaurant sales in northern Michigan counties, particularly those in the upper peninsula. Also, specialty food stores (dairy product stores, fruit and vegetable markets, etc.) will be less important in those counties with no large urbanized communities and more important in those counties with a highly concentrated population, i.e., Wayne, Ingham, etc. Grocery store sales will be relatively more important in rural counties where there are fewer specialty food stores.

CHAPTER VIII

APPLICATION OF PROJECTED DATA

Before even the most accurate projections can become useful, they must be applicable to the situation under examination. The validity of the projections made, can only be tested as time passes and the actual sales volume for a future year compared to the projected volume. Regardless, a projection procedure now exists and furnishes information for managerial decisions. Table 24 (Chapter VII) shows the absolute dollar value of the projections. The absolute value of the projected increase (or decrease) may be misleading since it does not describe the increase relative to the base period. Table 25 shows the projected percent increase in the deflated sales volume and is of more value when applying this data to problem solving discussions.

The data in Table 25 show that the volume of retail food sales in the state of Michigan will double from 1950 to 1990. This has numerous implications to the retail food industry.

Entire State

Since the data in Table 25 has been deflated, it represents a doubling of the physical volume of food involved

in the sales. In order to handle this increased volume of food sales, additional facilities will have to be made available. This is highly inconsistent with the present trend towards decreasing numbers of food stores. This trend is expected to level off within the near future (3 years) and the number of food stores then increase slightly towards the end of the 1980 projection period. Nevertheless, the major trend will be a continued increase in the size of the average grocery store. However, it must be noted that various recent studies have shown that the optimum sized grocery store (profit-wise) lies between \$1.5 to 2.0 million annual gross sales.¹ Still other studies have produced data showing increasing returns to scale as the size increases.² At present, however, the average Michigan food store is much smaller than this limit and has plenty of room for expansion.³

Figure 23 illustrates these results. Even as the average size of the grocery store increases, this expansion will not completely meet the expanded needs of consumers and this remaining volume may support the recently increased

¹"Colonial Study," Progressive Grocer, January 1964, p. C.12.

²McKinsey General Foods Study, General Foods Corporation, October 1963, p. 13, Exhibit 10.

³Duft and Brown, Table 12.

number of smaller "superettes" or so-called "convenience stores."

Food retailing will remain an industry of large numbers in spite of a pronounced decline in store numbers since 1950. The grocery store will become more important relative to the entire food industry as shown in Figure 22. Therefore, the retail food chains, affiliated and unaffiliated independent retailers will have to make numerous decisions concerning future expansion possibilities. Even if the expansion decision is made, further consideration will be necessary to decide whether this expansion will be vertical or horizontal; local, regional or state-wide; conducted by mergers or new construction; etc. There exists almost a certainty that food retailers will have to make major organizational changes in the future. As a result, the retailers will need to revise their marketing programs and methods. Regardless of what such changes will imply, the first and most important information needed is the market potential changes within the state. Even if the physical volume of retail food sales does double in the state of Michigan, the food industry is at a loss trying to meet these increased demands, unless it knows years of advance, just where, within the state, these changes will occur and the extent of this change. It is this type of information that the Composite County Projection Technique, described in this paper, was constructed to furnish. However, these composite sales projections should not be used by the

Table 25. Deflated Retail Food Sales.

County	(\$1000)					
	1951	% of 1951	1962	% of 1951	1965	% of 1951
Baraga	1,622	100	2,075	127.9	2,137	131.8
Missaukee	894	100	1,149	129.5	1,226	137.1
Berrien	42,531	100	56,439	132.7	61,966	145.7
Ingham	59,639	100	82,151	137.7	90,552	151.8
Wayne	925,845	100	989,899	106.9	993,971	106.8
State	2,138,200	100	2,779,642	130.0	2,339,797	109.4

County						
	1970	% of 1951	1975	% of 1951	1980	% of 1951
Baraga	2,273	140.4	2,354	145.1	2,365	145.8
Missaukee	1,071	119.8	819	91.6	491	54.9
Berrien	65,094	153.1	68,839	161.9	70,227	165.1
Ingham	97,638	163.7	103,092	172.9	107,843	180.8
Wayne	820,596	88.6	605,297	65.4	364,009	39.3
State	2,767,110	129.4	3,371,292	157.7	4,240,338	198.3

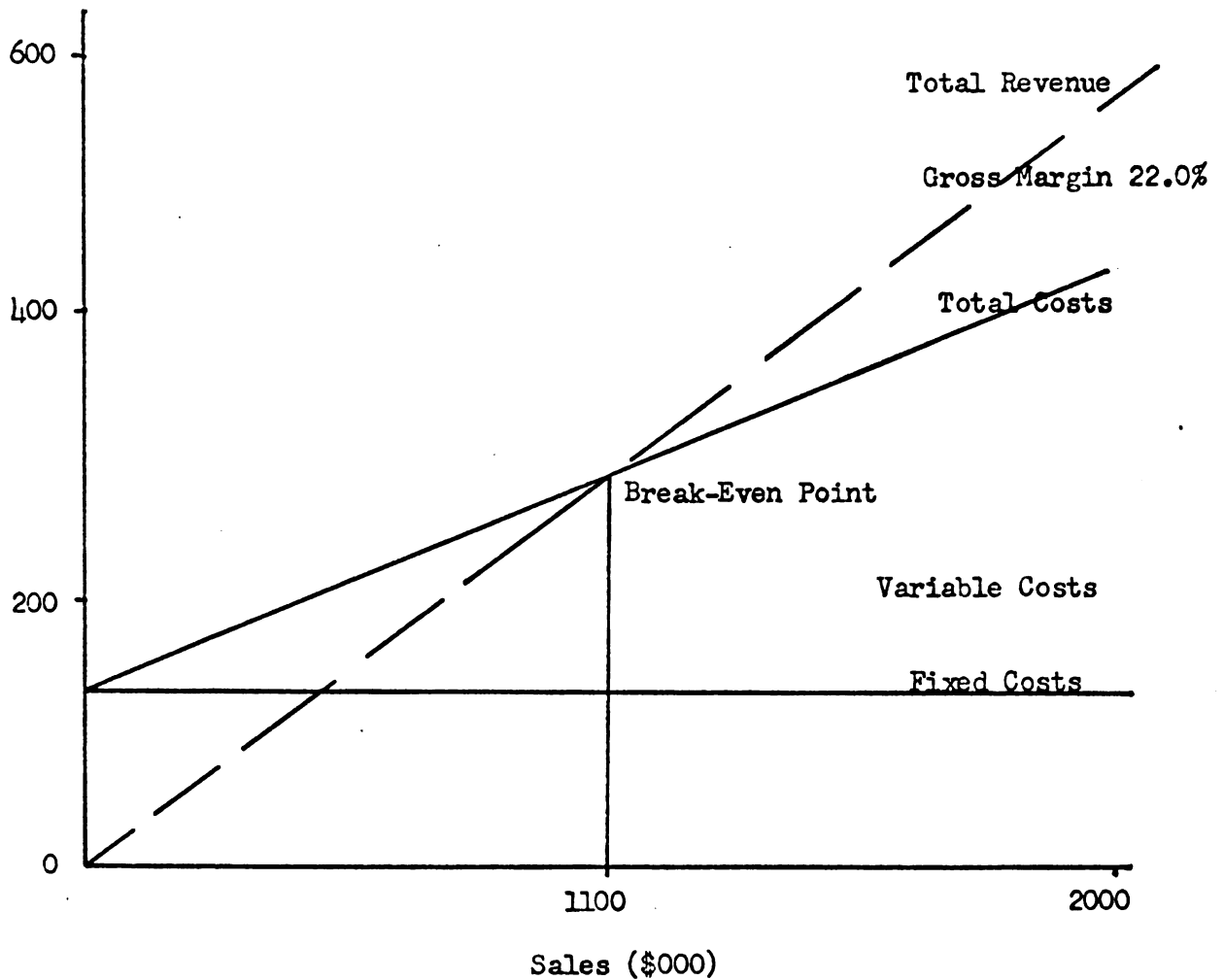
retail food industry as the only criterion on which expansion decisions are based. This composite technique only considers the population number of food stores and income factors and, therefore, is not designed to present a complete picture of a given market place.

The projection results should then be used as one of many factors to be considered in a complete market analysis. The amount of emphasis that should be placed on the projections, therefore, depends not only on the particular

Figure 3

Break-Even Analysis, Economies to Scale¹

Revenue & Profits
(\$000)



¹Duft, Kenneth D. "Profitability of a Transition Point Derived from Technological Changes in the Physical Distribution and Handling of Retail Food Products," M.S.U., December 5, 1963, pp. 24-25 (Unpublished).

situation involved, but also on the availability of information on the other important factors.

Metropolitan Areas

Michigan is characterized by having a large number of small regional food chain organizations (4-11 stores) as well as many of the national chains.¹ Where as the national chains are interested in evaluating all the markets throughout the state, but the regional chains and affiliated independents are more interested in analyzing the metropolitan area in which they operate. Michigan contains ten metropolitan areas and each can be analyzed and projections made in a manner similar to that conducted with the five selected counties. The metropolitan areas, consisting of two or more counties, can be studied by summing individual county data.

Even within a metropolitan area, special attention should be given to the outlying reasons behind certain county trends. For example, Wayne County, alone, presents an extremely misleading description of the Detroit Metropolitan Area. The projections show a decrease in the potential food sales in Wayne County, however, this decrease is outweighed by the expanding market of the surrounding counties.

The study conducted in the Chicago-Gary Metropolitan Area showed how the potential retail food market is moving

¹Duft and Brown, Table 16.

towards the suburbs and tends to follow the major traffic arteries. Since this is not just true for large cities like Chicago and Detroit, it produces unique problems when analyzing a metropolitan area. Therefore, even within a metropolitan area there may be variations between counties.

Counties

A county by county projection and analysis, like that performed for the five selected counties, is ideal for the large national food chain. This gives the industry a picture of potential sales throughout the entire state. Areas of increasing (or decreasing) sales potential can be determined allowing further decisions concerning future expansion plans. Now the retail food industry knows where (within the state) this doubling of food sales will probably occur.

One would expect that the southern counties will experience a greater increase in future retail food sales than will the northern counties. However, this generalization is not valid enough to base major managerial decisions on. Returning to Table 25, one finds a southern county such as Wayne showing a 1980 potential retail food sales volume only 39 percent of that in 1950 and a northern county such as Baraga with almost a 50 percent increase over 1950.

The importance of the Wayne County trends should not be underestimated. The magnitude of Wayne County food sales

alone, indicates the importance of this county in determining the entire state's projections.

The projected 1980 Wayne County food sales data need further explanation. The projected 1980 volume shows a rather sharp decrease from the 1950 volume. This trend, discovered during the 1951-62 observation period is justifiably attributed to the movement of Detroit's population out of the city and into the suburbs. Therefore, the 1980 projections are based on the assumption that urban renewal and the present population movements will continue. This assumption, alone, creates limitations worthwhile of additional consideration and comment.

For example, a more recent phenomena is the tendency for the upper income people to move back into the city once their children have left home. These people move into a small semi-luxury ultra modern apartment in the mid-city where the husband is within walking distance from the office and the wife need only walk across the street to the downtown shopping district. Although this latest trend is a far cry from the magnitude of the mass exodus experienced in the 1950's, it may be the beginning of something of great consequence within our metropolitan areas. Therefore, the Wayne County projections are extremely dependent on population trend assumptions and the projected decrease in potential sales may be an overestimate in view of the diminishing trend of Detroit's population exodus.

However, a detailed study such as this furnishes available information on the proper location of new facilities and expansion of those existing facilities.

The productive life of a new and modern retail food outlet, of supermarket size, is about twenty years. Therefore, before the investment on stores of this nature can be made, an analysis of the market for that twenty-year period must be conducted. Before a legitimate return on an investment can be anticipated, the consumer demand must exist not only now, but also in the future.

It must be noted, however, that this study's projections in no way detract from the requirement that every retailer must meet the task of serving consumers more effectively. For this is the heart of any consumer-oriented business such as food retailing.

Income Elasticity and Engel's Law

Income Elasticity (E)

Before the projection technique and its results can be discussed in relation to economic theory, the equation coefficients (especially b_2 , associated with deflated per capita disposable income) must be analyzed with regard to income elasticities and/or Engel's Law.

The equation usually used in determining the slope of Engel's curve and the income elasticity is of the form:

$$Y_1 = a_1 + b_1 X + U_1$$

where Y_i is the per capita expenditure on the i -th commodity (saving is included as a commodity) and X is per capita income,

$$\sum a_i = 0 \quad \sum b_i = 1$$

so that the sum of the expenditures on individual commodities is equal to total income, i.e. $Y_i = X$ at all levels of income.¹

The final technical criterion in the choice of a functional form to approximate the Engel curve is ease of numerical estimation. This criterion leads to a preference for forms which are suitable for regression equation estimation.²

The multiple linear equation used in this paper was basically of the form: $Y = a + b_1x_1 + b_2x_2 + u$ where Y is per capita deflated retail food sales, x_1 is the number of food stores, and x_2 is deflated per capita disposable income. The income elasticity of this equation is determined as shown in Table 26.

Table 26. Income Elasticity³.

Equation	Marginal Propensity to Consume $\frac{\partial Y}{\partial X_2} = \text{MPC}$	Income Elasticity $\frac{\partial Y}{\partial X_2} \cdot \frac{X_2}{Y} = E$
Linear	b_2	$b_2 \cdot \frac{X_2}{Y}$

¹Herrmann, Robert Omer. p. 75.

²Allen, R.G.D. and A.L. Bowley. Family Expenditure, ("London School of Economics and Political Science: Studies in Statistics and Scientific Method," No.2 London: Staples Press, 1935), pp. 1-53.

³Herrmann, p. 81.

Table 27 shows the result of the "E" calculation for the five selected counties and state.

Table 27. Income Elasticity of the Demand for Food (E).

County Code	X_2	Y	$\frac{X_2}{Y}$	b_2	E
#7	167.6061	31.6769	5.29	.0384	.203
#33	98.9064	19.0273	5.49	.0674	.370
#57	81.0550	25.8249	3.14	.2577	.809
#11	87.5973	12.1360	7.22	-.1268	-.915
#82	108.9785	22.9782	4.74	.1296	.614
State (#84)	179.8225	18.2014	9.82	.0552	.542

Table 27 shows an income elasticity of the demand for food (E) of .542 for the state, as a whole. When comparing this with past studies, this seems quite high. It indicates that as per capita deflated Disposable income increases by ten percent, per capita deflated retail food expenditures increase by 5.42 percent.

This may be attributed to the huge weighting effect Wayne County (E = .614) has on the state, as a whole.

However, it must also be mentioned the E cannot be considered the true income elasticity. True income elasticity is based on the assumption that "all" other variables are held constant. In the beginning portion of this paper the elimination of numerous variables from the equation under consideration was described. Therefore, now that many of these variables are no longer under consideration, one cannot

assume that they are remaining constant. Also a relatively high intercorrelation for the state would seem to reduce the accuracy of E.

Note that just as Mr. Herrmann found great variations in E between different sized households, Table 27 shows great variations in E among the five selected counties.

Again, the negative E shown for Berrien County is most difficult to explain unless it is attributed to the high amount of intercorrelation previously mentioned. In the remaining four counties, the E varies from .203 in Baraga County to .809 in Missaukee County.

Generally speaking, as would be expected, the E is higher in those counties with lower income levels.

<u>Ranking of Per Capita Disposable Income</u>			<u>E</u>
1.	Ingham	#33	.307
2.	Wayne	#82	.614
3.	Baraga	#7	.203
4.	Missaukee	#57	.809

Food expenditures show a low level of response to income level changes in Baraga County (.203) because of the magnitude of the tourism effect on food sales. Had the tourist effect been removed, it is expected that Baraga would be found consistent with the other three counties which show that as income level increases, its effect on food expenditures decreases.

Engel's Law

A b_2 coefficient of less than 1.0 for each of the 84 time series multiple linear regression equations illustrates

some endorsement of the existence of Engel's law under dynamic conditions. The preceding few paragraphs, which show a higher E for lower income counties, also tend to show that Engel's Law does exist under dynamic conditions. Both of these findings follow the basic hypothesis that poorer families spend a larger percent of their total income on food than do the higher income families. However, a negative b_2 was found in many counties. This phenomena still coincides with the basic requirement that as income increases, a lower percent is spent on food, but does not agree with the common assumption that Engel's Curve is positively sloped. Therefore, under dynamic conditions, Engel's Law does not perfectly apply throughout the state of Michigan.

The static conditions, illustrated in the cross sectional analysis, provided a b_2 which is not only less than 1.0, but also positive in nature. As was discussed in Chapter VII, the meeting of these two requirements indicates that Engel's Law does apply to the state of Michigan under static conditions, similar to those under which it was originally formulated.

Percent of Income Spent on Food

Of additional interest to the economist is information on the percent of total income spent on food during the twelve year period. Table 23 and Figure 24 present adequate data from which the reader may visualize the general trend.

Figure 24 best illustrates the tendency towards a decrease in the percent of income spent on food. This, of

course, coincides with the general increase in income levels throughout the state. Assuming this general trend continues, by 1980, less than fifteen percent of the average Michigan resident's per capita income will be spent on food.

Limitations to Long Run Economic Projections

Economic projections are widely used by businessmen looking to new markets and areas of possible expansion. A virtually insatiable demand for a peek at the future - even if clouded by uncertainty - has given rise to a host of longer run economic appraisals. Unfortunately, many of the more detailed studies consist largely of collections of data for past years and "numbers" projected on the basis of past trends.¹

Some of the basic limitations or deficiencies of long run projections, such as those made in this paper, are as follows:

- 1) Neither the economist nor anyone else can foresee the future. The economist must, therefore above all, appreciate the limitations of his tools and procedures.
- 2) Elaborate, detailed economic projections generally require more time and effort than can be justified even in an affluent society such as ours.

¹Daly, Rex F. "Long-Run Economic Projections: A review and Appraisal," Agr. Economics Research, Vol. XV, No.4, October 1963.

Table 23. Percent of Per Capita Disposable Income Spent on Food.

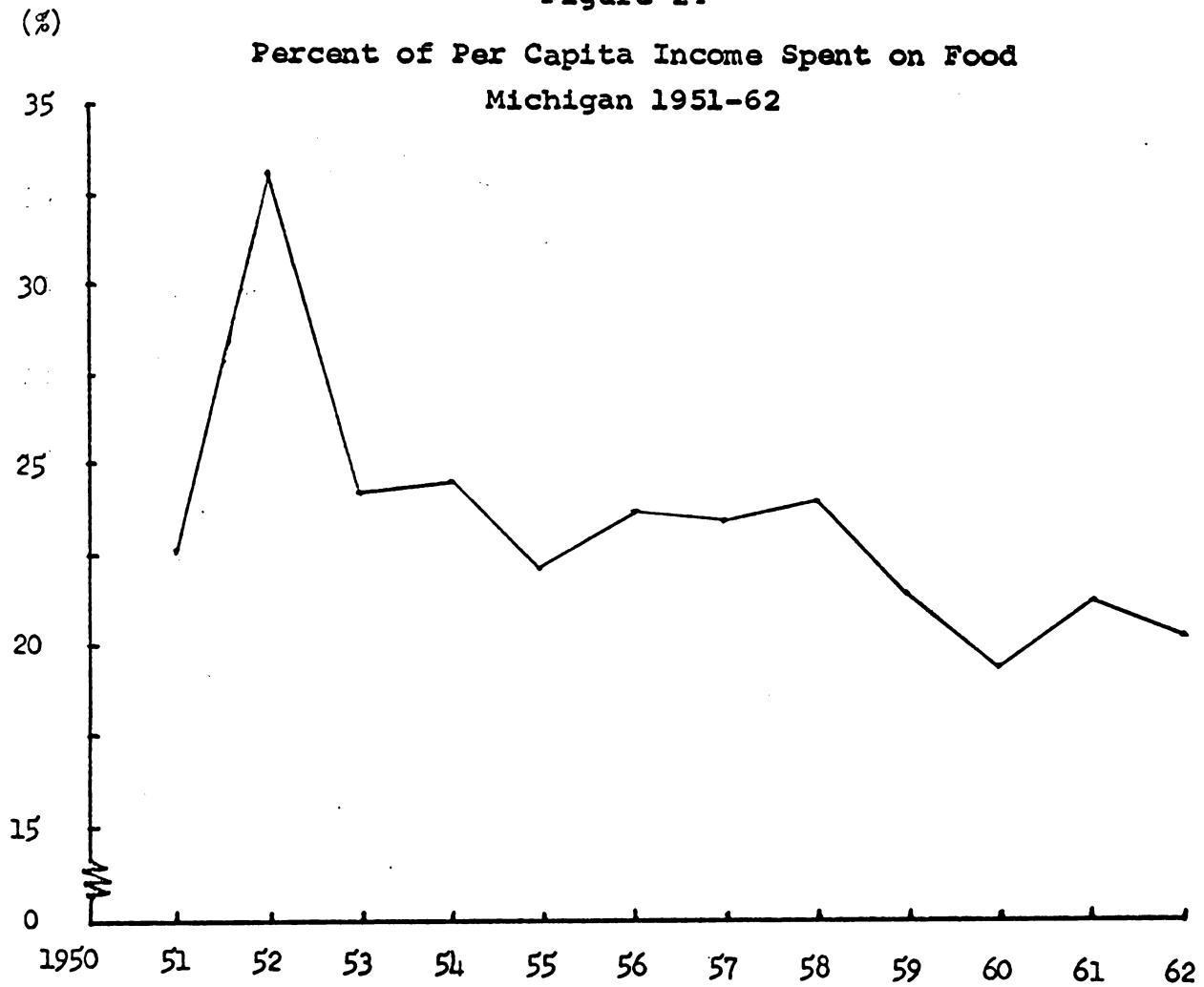
County (#)	1951	1952	1953	1954	1955	1956
Baraga (7)	13.86	26.53	24.94	25.34	23.53	24.22
Missaukee (57)	17.91	18.98	19.91	20.02	18.69	19.11
Berrien (11)	18.46	19.82	20.29	20.19	19.35	19.74
Ingham (33)	14.95	16.05	15.41	15.40	14.74	15.18
Wayne (82)	19.67	24.50	25.88	25.81	24.67	25.21
State (84)	22.67	33.10	24.19	24.32	22.20	23.68

County (#)	1957	1958	1959	1960	1961	1962	Average
Baraga (7)	22.50	21.92	20.51	21.21	20.83	21.59	22.26
Missaukee (57)	17.81	16.55	15.45	15.83	17.34	17.25	17.90
Berrien (11)	19.27	19.63	18.29	18.12	17.65	17.53	19.03
Ingham (33)	15.15	15.89	14.97	14.20	16.39	16.45	15.40
Wayne (82)	23.94	23.83	22.21	22.80	22.24	22.35	23.59
State (84)	23.38	23.92	21.59	19.33	21.18	20.30	23.33

3) Most long run decisions have many facets - economic, social, welfare, national security, etc., and no economic or other analytical framework can be expected to give unequivocal conclusions regarding the whole picture of the future.

The economic projection attempts a view of the future based primarily on present knowledge and relationships of the recent past. Usually the strategic assumptions are given and much of the projection follows logically from these assumptions. Accordingly, the projection is not an unconditional "forecast" of the future, but is an appraisal based on a

Figure 24



number of specific assumptions.¹ Such assumptions make the projection job manageable, but just as often as not, they are

¹Daly, p. 114.

a dodge which simplifies the job and limits its usefulness.

The long run economic projection, consequently, can be little more than a rough sketch of future growth based on past trends and economic relationships. Such projections seldom reveal new problem areas, but help to quantify those known problems.

The composite method of projection, as discussed in this paper, does contain a limitation which is unnoticeable under average conditions. However, it might become more evident if projections are made for all of the 83 counties rather than for just a selected few, as was done in this paper.

Due to the characteristics of the exponential equation used in the composite process, the sum of the 83 county retail food sales projections will not necessarily equal the state projection for a given year.¹ Although this phenomena tends to give the composite technique an unrealistic character, it is not totally unyielding in nature.

The most conventional way of correcting this "error" seems to be as follows:

- 1) Assume the state projection to be correct since the state data will have averaged out those counties with rather extreme trends,
- 2) Determine the percent the sum of the county projections is above or below the state projection, and

¹This is also true of the simple regression technique and others except for a purely linear projection.

3) Subtract or add this percent of each county's projection to the original county projection so that the sum of the county projections equal the state projection. Despite the fact that this adjustment is most arbitrary, it seems to be the best correction device presently available.

CHAPTER IX

SUMMARY AND CONCLUSIONS

This chapter will consist of summaries and conclusions of the results. Each of these objectives of the study are again stated, followed by a short explanation of findings of this study as they pertained to that particular goal.

Reaching the Objectives

Objective #1: Determine the relationship and significance of economic and sociological factors in explaining variations in gross sales over time by counties, metropolitan areas, and state.

Chapter V explains the process (time-series multiple linear regression analysis) in which four trial runs were conducted to determine the factors that have the major effect on variations in retail food sales. Following the elimination of those factors with a high degree of intercorrelation or an insignificant effect, it was found that population was of such great importance, both in magnitude and in significance, that it concealed any relationships that might exist between food sales and other factors.

In the third trial run it was decided to remove the effect of population from the regression equation by converting

the total retail food sales into per capita retail food sales. In the fourth and last trial run it was discovered that both number of food stores and deflated per capita income had an effect on deflated per capita retail food sales. The results of a five county regression analysis presented in Chapter VI show great variation among the counties. $\bar{R}^2$ varies from a high of .955 to a low of .132 and TB from 2.1365 to .3705. Generally, it was found that the number of food stores in a county had an inverse relationship to that county's retail food sales. The magnitude of this relationship was greater for the northern Michigan counties and was attributed to the decrease in the number of small country stores, leaving only the larger and more efficient stores which locate in a central retail sales area where the drawing power is increased.

In a majority of the counties it was found that (as is normally expected) the level of per capita income has a direct effect on per capita food sales. However, as shown in Map #4, many counties showed income to have an inverse effect. Explanation of this phenomena is beyond the scope of this study, but does indicate an area in which further study is greatly needed.

Objective #2: Determine the significance of related factors in explaining variations in gross sales among the 83 counties for the years 1951-62.

Table 17 in Chapter V shows the results of the cross sectional multiple linear regression analysis. This cross sectional analysis was conducted to determine what effect, if any, the number of food stores and per capita income level had on variations of gross sales among counties in a given year.

The equation results show that both factors had a significant effect on food sales during the years 1951-57. However, during this time period, the percent of variation in gross retail food sales explained by the two factors (R^2) decreased from 45 percent to only 7.3 percent. During the first seven years of the observation period (1951-62), both the number of stores and per capita income level were found to have a positive and fairly significant effect on gross retail food sales.

Objective #3: Formulate a basic statistical procedure which would use the relationships determined in (1) and (2) to project the potential food sales volume by county, metropolitan areas, and state to the year 1980.

Chapter VII presents a detailed explanation of the statistical procedure advocated in this paper. Its step by step process can be summarized as follows:

Step 1: projection of the food price index number using a simple curvilinear regression equation.

Step 2: projection of the consumer price index also using the simple curvilinear regression equation.

Step 3: projection of the number of food stores for a given county, again using the simple regression equation where time is the independent variable and number of food stores the dependent variable,

Step 4: projection of per capita disposable income level in a given county using the simple curvilinear regression equation and projecting the data over time.

Step 5: transforming per capita disposable income data into deflated per capita disposable income by dividing the non-deflated data by the projected consumer price index,

Step 6: projection of the deflated per capita gross retail food sales for a given county using a multiple linear regression equation,

Step 7: projection of the non-deflated gross retail food sales for a given county by multiplying the projected deflated per capita sales data by the projected food price index,

Step 8: projection of total deflated gross retail food sales for a given county by multiplying the projected deflated per capita sales data by the projected population of that particular county,

Step 9: transformation of the deflated county retail food sales data projections into non-deflated projections using the projected food price index as it was used in the seventh step,

Step 10: projection of gross retail food sales for a given year using a simple curvilinear regression equation as in steps 1 thru 4 so that the results of this simple projection over time can be compared with those of the Composite Method (Steps 1 thru 9) developed in this paper.

Step 11: transformation of this simple projected food sales datum into a deflated value again using the projected food price index,

Step 12: the actual comparison of the Composite Method projections with the simple curvilinear projections over time so that both methods may be evaluated and the most realistic and applicable technique selected. Following a detailed analysis in Step 12 it was concluded that in each of the five selected counties and the state, the Composite Method of projection was the most realistic and applicable. Its accuracy can only be determined over the time period for which projections were made.

Objective #4: Predict the proportion of projected retail food sales which will be associated with the different types of retail food sales.

In Figure 22 of Chapter VII, data is given which shows the percent of total retail food sales which occurred in each of the general types of food stores during the observation period.

As might be expected, the percent of total retail food sales taking place in grocery stores has increased over the twelve year period, while the proportion of sales attributed to the other types of food stores decreased. Assuming this trend continues, by 1980 approximately 80 percent of all retail food sales will occur in grocery stores.

Relatively unexpected, however, is the slight decline in the relative importance of food sales in restaurants. The data show that despite a continued increase in the absolute volume of food sales in restaurants, the importance of this sales volume relative to total retail food sales will slowly decline until it reaches 10 percent in 1980, when it is expected to level off if not increase slightly.

Sales in specialty food stores such as dairy product stores and fruit or vegetable markets is expected to decrease, relative to total food sales, until it is less than 3 percent in 1980.

Also, by 1980 retail food sales in taverns and clubs are expected to decrease to approximately 5 percent of total sales. The remaining 2 percent of total 1980 projected potential retail food sales will be the result of sales in miscellaneous stores such as delicatessens, candy stores, etc.

In summary, the grocery store will eventually become the dominant outlet for all food sales. Therefore, the grocery store organizations should be the primary sector of the retail food industry which is interested in sales volume projections.

Objective #5: Derive, explain, and analyze income elasticity of the demand for food in Michigan during the twelve year observation period.

Table 26 of Chapter VIII illustrates the procedure used to convert the per capita income coefficient of the multiple linear regression equation into a numerical measure of the income elasticity of the demand for food. Table 27 of the same chapter shows the results of the conversion as it was applied to the regression equations of the five selected counties and the state as whole.

The results show that the income elasticity of the demand for food for the entire state of Michigan is .542. The elasticity of the five selected counties varies somewhat. However, once those counties showing a negative income coefficient are disregarded and the tourism effect is removed from the upper peninsula counties, there is found a consistency in those remaining counties whereby those counties with the highest level of per capita income also have the lowest income elasticity. This seems quite logical since it is normally expected that as one's income level increases, he will spend a steadily decreasing proportion of that increase in income on food products.

Objective #6: Analyze the results and convert the projections into suggestions of how this data might be applied by the retail food industries in their future planning.

Chapter eight deals with the interpretation of the test results in the context of applying projections to the retail food industry and its overall market analysis.

The size of the organization interested in the data (local, regional, or national membership) largely determines the size of the market on which these projections are needed. For example, the small local retail food store association may only be interested in the projections for one particular county, whereas a regional group may need to use and apply data from a large metropolitan area and a national food chain be interested in a county by county analysis and comparison throughout the entire state.

The projections show a 150 percent increase in the dollar volume of retail food sales in Michigan from 1950 to 1980 and a 100 percent increase in the physical volume of food products being handled. The retail food industry must now decide in what areas of the state these increases (or decreases) will be most pronounced so that additional facilities can be established to cope with this increased product demand. Regardless of the direction, if this proposed expansion of retail food marketing facilities is to be horizontal, vertical, enlargement of existing outlets, or the addition of new outlets, the industry must first know the area of this potential increased sales before any decisions can be made on the expansion process. It is in this area that the projected potential retail food sales of a given area (or areas) can be most appropriately applied.

Testing the Hypothesis

The final discussion will deal with the acceptance or rejection of the hypotheses presented at the beginning of this paper.

General Hypotheses: Once the significance of factors has been determined, statistical procedures such as a multiple linear and simple curvilinear regression analysis may be applied to accurately project into the future potential gross retail food sales by county, metropolitan area, and state.

Even in all due respect to the complexity of the general hypotheses, it is accepted on the following bases:

- 1) Two factors were found to have a significant effect on the volume of retail food sales and these relationships were later used in the projection technique.
- 2) The Composite Method of regression analysis and projection, used in this paper, produced projections of retail food sales more realistic and applicable than the most commonly used technique.
- 3) The Composite Method is basically justifiable by economic and statistical theory as well as logical reasoning.
- 4) Despite some unexplained irregularities, most consumer behavior patterns were consistent with the test results, i.e., Engel's curve.
- 5) Final evaluation of the accuracy of the projections must be delayed until the time, for which the projections were made, has passed and the actual sales volume determined.

Sub Hypotheses #1: Despite the emphasis placed on the measurement of the income elasticity of the demand for food on a national basis, a much more detailed analysis is necessary before this national measurement can accurately be applied to an individual area as small as a county.

This hypotheses is also accepted on the basis of the information presented in Table 27 which shows that income elasticity varies greatly among counties. Had the income elasticity for the state (.542) been applied to each individual county, the results would be extremely misrepresentative. Likewise, therefore, it is also highly inaccurate for anyone to apply the national income elasticity to any one individual state. A detailed analysis must be made of the specific area under consideration before it can be determined if that area's true income elasticity coincides with being applied to it.

Sub Hypotheses #2: The proportion of total gross retail food sales attributed to grocery stores will change only slightly in Michigan's near future.

This hypotheses is rejected on the basis of the trends shown in Figure 22 of Chapter VII. As was previously discussed under Objective #4, the trend indicated that by 1980 almost 80 percent of all retail food sales will occur in grocery stores. This is almost a 33 percent increase in the proportion shown in 1950 and a 17 percent increase from that proportion shown in 1962. This seems to be a rather significant change and serves as justification for the rejection of the hypotheses.

Sub Hypotheses #3: Relationships found between variable factors and gross retail food sales vary so greatly among the 83 Michigan counties that an individual county analysis must be conducted to obtain accurate and applicable results.

Information presented in Maps 2 thru 5 in Chapter VI provide the basis on which this hypothesis is accepted. While testing the effect of the number of food stores and the per capita disposable income has on deflated per capita retail food sales, R^2 was found to vary from .21 to .96, b_1 varied from 6.0 to -18.87, b_2 varied from -.147 to .257 and T_3 varied from -15.6 to 6.73 in the multiple linear regression equation used to project deflated per capita retail food sales. This variation, in the importance, magnitude, direction and significance of the effect the two independent variables have on the dependent variable, illustrates the validity of the hypotheses. Before an accurate and applicable market analysis can be made, a county by county study must be conducted so as to take into consideration intra-county differences.

Concluding Statement

The need for long-run economic projections as an aid in policy formulation is fairly obvious. Most economic decisions, whether to invest in a new retail food outlet, build a dam, or to continue one's education, involve judgments about the future. To the extent that it is effective, the long-run appraisal may be proven incorrect, if problem areas

are revealed and action taken to correct them. For as Mr. Daly once stated, "Economic projections, in influencing long-run judgments and policy formulation, may generate the conditions which prove them wrong."¹

Retail food marketing is a highly complex business. The factors effecting profits are almost countless; the relationships between them are intricate. While planning for new stores is vitally important, so is pricing, controlling labor expense and making superior merchandising decisions. Pinning down the degree to which these salient management functions influence profits is difficult.

These unique conditions define the fundamental economics of this industry and hence shape its management problems. Simply being aware of these forces, however, is clearly not enough. Measuring them and determining more exactly their impact on profits and other market conditions is what is needed to take the appropriate action. In presenting this paper, it has been my objective to cast just one of these problems and requirements in a new light - a more exact light - so that better decisions can be made by better informed executives and other men within the Michigan retail food industry.

¹Daly, p.113

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APPENDIX A

MICHIGAN RETAIL FOOD SALES DATA

APPENDIX A

Annual Gross Retail Food Sales for Michigan Counties

(\$000)

#	County	1951	1952	1953	1954	1955	1956	1957	1958
1	Alcona	1,079,966	1,257,700	1,380,733	1,961,500	1,931,166	1,739,850		
2	Alger	2,444,766	2,985,200	2,966,166	3,618,233	3,532,166	3,401,350		
3	Allegan	12,744,600	14,783,933	15,094,400	18,528,466	19,598,833	18,838,350		
4	Alpena	7,357,766	8,472,166	9,187,166	12,115,633	12,646,833	12,890,725		
5	Antrim	2,825,500	2,926,633	3,040,666	3,622,466	3,998,566	4,227,600		
6	Arenac	2,293,766	3,246,400	3,451,266	3,853,600	4,299,900	4,464,650		
7	Baraga	1,895,633	1,936,596	1,861,500	2,704,366	2,307,266	2,505,675		
8	Barry	6,585,100	7,307,166	7,847,233	9,166,666	10,768,233	10,579,275		
9	Bay	30,556,333	33,720,833	35,248,900	42,092,500	43,693,900	42,494,625		
10	Benzie	2,262,800	2,433,733	2,668,300	3,108,866	3,210,533	3,184,825		
11	Berrien	47,327,433	53,966,700	54,501,066	63,108,966	66,119,233	68,178,125		
12	Branch	7,693,333	9,291,133	8,966,900	9,945,466	10,433,333	11,354,575		
13	Calhoun	44,529,500	50,041,500	49,215,666	58,313,700	63,025,166	61,893,775		
14	Cass	7,581,333	8,845,933	8,647,933	10,605,233	11,230,100	10,774,950		
15	Charlevoix	4,246,866	4,767,933	5,279,966	5,990,000	6,427,533	6,003,775		
16	Cheboygan	4,815,666	5,525,833	5,957,800	8,212,866	8,581,333	7,895,450		
17	Chippewa	9,518,533	10,785,033	11,826,533	13,561,333	14,362,266	13,493,325		
18	Clare	4,356,866	4,695,533	4,976,733	5,912,666	6,176,066	6,416,675		
19	Clinton	5,966,733	5,773,366	7,161,101	8,790,900	10,134,200	10,604,975		
20	Crawford	1,689,766	1,917,033	1,876,666	2,390,833	2,592,866	2,755,825		
21	Delta	11,304,900	12,194,233	12,208,233	14,711,500	14,592,866	16,711,325		
22	Dickinson	7,393,166	8,090,833	8,319,133	9,903,066	10,497,666	10,738,075		
23	Eaton	10,304,400	11,802,733	12,007,733	14,032,733	14,603,800	16,350,825		
24	Emmet	5,572,300	6,031,100	6,074,266	7,744,600	8,195,099	8,679,825		
25	Genesee	99,355,333	116,177,533	141,523,700	152,231,900	153,856,666	164,073,300		
26	Gladwin	2,545,766	2,874,900	3,009,900	3,982,100	4,041,133	4,099,875		
27	Gogebic	8,046,666	9,671,966	9,427,700	11,168,800	10,135,233	10,081,875		
28	Grand Traverse	10,883,633	11,852,333	13,025,966	16,420,600	16,617,633	16,883,075		

APPENDIX A

Annual Gross Retail Food Sales for Michigan Counties (2)

#	County	1951	1953	1955	1958	1960	1962
29	Gratiot	8,787,900	9,834,300	10,303,466	12,190,033	12,758,300	12,640,750
30	Hillsdale	7,303,766	8,142,633	7,411,733	8,660,400	9,804,900	10,452,900
31	Houghton	11,683,733	12,293,100	12,755,633	14,635,333	14,919,500	13,640,725
32	Huron	8,158,200	9,303,300	10,301,266	12,010,066	12,014,966	12,312,375
33	Ingham	66,376,066	76,776,566	79,320,133	91,939,333	95,163,166	99,238,850
34	Ionia	9,502,200	10,546,766	11,240,033	13,391,833	13,611,600	13,918,925
35	Iosco	4,192,700	4,926,566	5,312,166	7,417,866	8,383,633	8,365,425
36	Iron	6,511,766	7,309,300	7,180,300	7,945,133	7,809,366	7,668,475
37	Isabella	6,453,133	7,395,433	7,585,066	9,911,100	10,463,533	11,105,225
38	Jackson	30,693,966	44,576,266	41,107,200	47,438,966	50,921,233	53,841,575
39	Kalamazoo	44,499,200	49,829,023	53,769,133	67,652,166	75,043,666	74,791,950
40	Kalkaska	1,033,633	1,187,666	1,201,500	1,509,133	1,429,600	1,401,000
41	Kent	109,164,033	120,280,900	130,535,166	148,430,833	157,391,800	157,804,475
42	Keweenaw	623,966	731,333	795,133	1,003,466	1,002,266	936,325
43	Lake	1,246,066	1,506,100	1,535,766	1,965,066	2,058,433	2,048,825
44	Lapeer	8,050,566	8,427,700	9,507,166	12,201,066	12,846,733	12,881,650
45	Leelanau	1,891,100	2,229,300	2,260,433	2,544,700	2,697,933	2,385,550
46	Lenaawee	21,797,100	24,693,166	23,154,533	26,495,300	27,033,733	27,938,550
47	Livingston	8,022,633	9,194,900	10,164,600	12,925,466	13,702,500	13,752,975
48	Luce	2,100,833	2,241,800	2,237,200	2,769,333	2,897,166	2,591,150
49	MacKinnac	3,904,900	4,573,366	5,650,100	6,385,400	6,417,500	5,495,700
50	Macomb	72,299,800	87,541,233	102,999,400	145,416,500	162,769,533	178,044,175
51	Manistee	5,364,200	6,206,833	6,264,000	7,932,700	8,160,900	8,267,675
52	Marquette	16,427,766	16,143,766	18,248,000	22,531,200	23,427,833	23,408,825
53	Mason	6,457,666	7,126,766	7,574,633	9,514,066	9,980,333	9,818,275
54	Mcosta	4,715,700	4,915,033	5,410,700	6,873,300	7,127,466	7,165,600
55	Menominee	5,791,400	6,174,600	6,366,933	7,100,333	7,824,766	8,153,600
56	Midland	11,175,333	12,862,666	13,594,900	18,138,233	18,723,566	19,823,225
57	Missaukee	994,866	1,114,300	1,193,966	1,595,100	1,563,166	1,398,600
58	Monroe	23,254,143	27,242,433	27,639,733	30,286,833	30,945,400	31,463,075
59	Montcalm	9,180,832	10,580,866	10,962,800	14,105,466	14,789,766	14,948,950

APPENDIX A Annual Gross Retail Food Sales for Michigan Counties (3)

#	County	1951	1953	1955	1958	1960	1962
60	Montmorency	1,210,777	1,191,466	1,501,400	1,786,466	1,972,733	1,814,225
61	Muskegon	44,961,433	51,727,233	51,985,600	59,501,233	64,149,800	62,680,750
62	Newaygo	5,055,433	5,710,666	6,260,466	7,670,600	8,052,633	8,261,100
63	Oakland	163,467,400	194,668,833	227,319,233	278,373,066	302,905,400	316,818,150
64	Oceana	4,499,100	5,007,600	4,975,800	5,692,233	5,942,800	6,193,375
65	Ogemaw	2,829,500	3,305,933	3,156,933	3,959,866	4,521,966	4,587,200
66	Ontonagon	2,088,266	2,627,023	3,038,033	3,449,166	3,453,700	3,746,550
67	Osceola	2,597,466	3,246,433	3,150,300	3,811,200	3,942,300	4,333,825
68	Oscoda	306,566	949,733	975,200	1,167,966	1,410,466	1,553,725
69	Otsego	2,528,900	3,021,133	3,139,566	3,930,766	4,200,966	4,112,200
70	Ottawa	20,577,133	23,507,366	25,195,933	31,849,200	33,609,466	34,553,175
71	Presque Isle	3,329,666	3,611,200	3,914,000	4,597,500	4,731,533	4,727,250
72	Roscommon	3,848,266	4,566,166	4,813,400	5,567,600	5,793,066	5,679,150
73	Saginaw	51,919,766	59,490,533	65,093,433	72,826,233	77,240,400	78,900,100
74	St. Clair	32,958,900	37,966,566	39,047,266	43,478,100	46,022,133	44,617,950
75	St. Joseph	11,210,133	12,365,666	12,978,633	14,571,966	15,932,300	16,810,200
76	Sauillac	7,057,566	7,844,333	8,291,566	10,018,733	10,776,833	10,659,125
77	Schoolcraft	2,352,133	3,636,633	3,811,333	4,457,400	4,661,833	3,945,225
78	Shiawassee	14,197,700	15,611,400	16,290,600	18,679,166	19,639,233	19,706,900
79	Tuscola	9,100,433	10,122,066	10,951,366	12,494,966	12,929,300	13,205,200
80	Van Buren	12,522,500	14,491,633	15,504,333	18,904,833	20,476,100	21,300,925
81	Washtenaw	43,121,566	54,526,066	55,742,266	70,221,633	73,007,866	76,345,625
82	Wayne	1,020,466,200	1,160,301,733	1,169,599,766	1,264,367,900	1,251,656,333	1,195,798,750
83	Wexford	5,695,400	6,207,766	6,389,333	7,589,300	7,953,666	8,154,350

84 STATE TOTAL

2,379,817,166 2,703,328,733 2,858,461,799 3,264,480,133 3,374,680,632 3,357,807,900

Number of Food Stores

#	County	1951	1953	1955	1957	1959	1962
1	Alcona	31.6	30.0	27.0	21.0	19.0	25.4
2	Alger	30.5	34.5	32.0	32.0	32.0	16.4
3	Allegheny	120.0	117.0	110.7	110.0	112.0	95.6
4	Alpena	74.5	69.0	67.0	70.0	67.0	67.5
5	Antrim	34.1	29.5	25.5	25.0	22.0	19.2
6	Arenac	20.1	25.5	21.0	40.0	42.0	44.6
7	Baraga	12.1	15.5	14.0	14.0	12.0	10.0
8	Barry	71.0	60.5	53.7	50.0	42.0	35.0
9	Bay	273.1	250.5	230.0	235.0	221.0	203.4
10	Benzie	35.1	34.5	32.0	20.0	20.0	21.3
11	Berrien	320.6	299.0	232.2	265.0	247.0	230.2
12	Branch	70.0	70.0	66.0	65.0	61.0	50.3
13	Calhoun	250.9	237.5	224.0	215.0	200.0	186.2
14	Casa	92.0	79.0	77.0	77.0	70.0	73.2
15	Charlevoix	40.0	42.0	30.5	27.0	20.0	20.4
16	Cheboygan	64.0	55.5	51.3	52.0	47.0	42.0
17	Chippewa	101.5	82.5	74.0	77.0	53.0	41.4
18	Clare	31.5	29.5	30.3	40.0	40.0	40.0
19	Clinton	64.5	59.5	50.2	54.0	50.0	46.0
20	Crawford	15.0	14.0	12.5	11.0	10.0	8.3
21	Delta	104.5	93.5	86.5	82.0	74.0	66.8
22	Dickinson	80.0	80.0	76.5	75.0	71.0	67.4
23	Eaton	103.5	98.5	92.2	81.0	75.0	60.8
24	Emet	62.0	59.5	51.2	21.0	24.0	16.0
25	Genesee	600.4	550.0	519.2	475.0	440.0	392.8
26	Gladwin	34.0	20.0	33.3	49.0	51.0	54.0
27	Gogebic	31.5	74.5	69.5	65.0	60.0	55.0
28	Grand						
	Traverse	90.5	77.5	74.2	69.0	66.0	62.8
29	Gratiot	102.6	95.0	85.7	70.0	61.0	52.0
30	Hillsdale	79.4	67.0	60.7	60.0	52.0	45.4
31	Houghton	150.6	135.0	121.5	105.0	91.0	77.6
32	Huron	92.0	82.0	83.8	104.0	103.0	104.2

APPENDIX A
Number of Food Stores (2)

#	County	1951	1953	1955	1959	1962
33	Ingham	352.5	321.5	303.0	291.0	251.0
34	Ionla	87.5	74.5	67.2	65.0	49.6
35	Iosco	50.2	56.5	55.0	55.0	51.4
36	Iron	40.6	42.0	40.3	47.0	42.2
37	Isabella	50.5	52.5	54.3	64.0	64.6
38	Jackson	232.9	249.5	228.7	196.0	148.6
39	Kalamazoo	215.4	227.0	215.5	206.0	198.2
40	Kalkaska	17.0	16.0	14.7	14.0	12.0
41	Kent	662.1	607.5	534.9	599.0	546.2
42	Keweenaw	15.0	12.0	11.5	10.0	6.4
43	Lake	20.1	22.5	19.3	22.0	16.4
44	Lapeer	60.1	76.5	63.5	68.0	52.0
45	Leelanau	22.1	23.5	27.2	25.0	23.0
46	Lenawee	170.0	153.5	142.0	133.0	103.2
47	Livingston	70.1	61.5	56.4	55.0	44.0
48	Luce	21.4	10.0	16.5	12.0	6.4
49	MacKinnac	52.4	48.0	46.5	43.0	44.4
50	Macomb	412.5	421.5	433.9	457.0	481.2
51	Manistee	71.0	65.0	57.7	45.0	27.2
52	Marquette	139.1	134.5	130.7	127.0	113.4
53	Mason	74.1	73.5	66.5	47.0	34.4
54	Mecosta	51.0	45.0	40.0	34.0	24.0
55	Menominee	70.0	66.0	63.0	60.0	54.0
56	Midland	94.6	93.0	87.0	72.0	61.4
57	Missaukee	31.5	18.5	17.5	19.0	17.0
58	Monroe	175.1	156.5	140.0	119.0	95.6
59	Montcalm	67.0	65.0	79.3	60.0	67.0
60	Montmorency	10.4	10.0	16.2	16.0	14.2
61	Muskegon	287.1	308.5	274.7	247.0	175.0
62	Newaygo	63.4	55.0	52.5	57.0	50.2
63	Oakland	785.4	745.0	743.5	799.0	737.0

APPENDIX A
Number of Food Stores (3)

#	County	1951	1953	1955	1959	1960	1962
64	Oceana	45.4	48.0	46.0	37.0	35.0	34.2
65	Ogemaw	43.1	38.5	31.0	16.0	9.0	1.8
66	Ontonagon	31.4	27.0	25.3	26.0	24.0	22.2
67	Osceola	40.6	37.0	34.2	32.0	29.0	26.4
68	Oscoda	16.5	17.5	16.2	11.0	10.0	8.8
69	Otsego	23.4	23.0	22.7	22.0	22.0	21.8
70	Ottawa	183.9	175.5	175.5	195.0	192.0	191.4
71	Presque Isle	45.4	41.0	39.8	42.0	40.0	38.6
72	Roscommon	52.9	47.5	45.5	47.0	44.0	41.8
73	Saginaw	303.0	333.0	316.7	313.0	294.0	277.2
74	St. Clair	283.0	246.0	225.7	193.0	177.0	156.6
75	St. Joseph	95.1	83.5	82.2	74.0	60.0	62.0
76	Sanilac	96.1	85.5	73.0	72.0	54.0	44.6
77	Schoolcraft	35.0	31.0	28.0	25.0	22.0	19.0
78	Shiawassee	104.1	95.5	93.0	119.0	119.0	121.2
79	Tuscola	113.0	111.0	105.0	89.0	85.0	79.2
80	Van Buren	107.4	103.0	101.8	104.0	102.0	100.6
81	Washtenaw	221.9	206.5	194.5	181.0	168.0	155.8
82	Wayne	6,435.0	5,959.0	5,522.0	5,010.0	4,552.0	4,110.0
83	Wexford	53.5	52.5	51.7	51.0	50.0	49.2
84	STATE TOTAL	16,530.5	15,209.5	14,292.3	13,529.0	12,595.0	11,572.0

Per Capita Disposable Income

#	County	1951		1953		1955		1958		1960		1962	
		Per	Capita Family	Per	Capita Family	Per	Capita Family	Per	Capita Family	Per	Capita Family	Per	Capita Family
1	Alcona	1,079	3,746	803	2,960	888	3,218	1,062	6,490	1,004	6,427	1,300	4,442
2	Alger	1,330	4,586	1,118	3,778	1,248	4,392	1,337	4,681	1,537	5,237	1,306	4,730
3	Allegan	1,189	3,982	1,154	3,769	1,297	4,294	1,420	4,827	1,536	5,211	1,655	5,849
4	Alpena	1,548	5,644	1,151	4,054	1,229	4,340	1,327	4,690	1,476	5,275	1,502	5,427
5	Antrim	969	3,202	820	2,553	919	2,973	1,076	4,746	1,124	4,030	1,297	4,319
6	Arenac	1,220	4,270	947	3,199	1,066	3,768	1,233	4,383	1,326	4,688	1,341	4,583
7	Baraga	1,486	5,016	870	2,989	967	3,278	1,113	3,649	1,202	4,064	1,232	4,288
8	Barry	1,017	3,349	1,232	3,907	1,342	4,340	1,462	4,701	1,612	5,156	1,783	6,076
9	Bay	1,423	5,078	1,450	4,993	1,546	5,394	1,592	5,565	1,792	6,248	1,754	6,236
10	Benzie	1,564	5,130	914	2,883	1,013	3,283	1,144	4,029	1,260	4,466	1,368	4,394
11	Berrien	1,517	5,018	1,439	4,593	1,571	5,087	1,635	5,303	1,838	5,964	1,963	6,668
12	Branch	1,345	4,628	1,158	3,869	1,312	4,465	1,410	4,775	1,598	5,355	1,900	6,758
13	Calhoun	1,470	5,108	1,565	5,261	1,712	5,848	1,761	6,012	1,945	6,730	2,059	6,951
14	Cass	1,048	3,386	1,190	3,701	1,324	4,201	1,446	4,594	1,602	5,046	1,662	5,701
15	Charlevoix	1,345	4,642	880	3,026	985	3,460	1,115	3,946	1,236	4,358	1,371	4,583
16	Cheboygan	1,502	5,237	815	2,802	915	3,216	1,044	3,740	1,164	4,143	1,248	4,495
17	Chippewa	1,509	5,448	1,179	4,147	1,260	4,513	1,466	5,204	1,670	5,785	1,427	5,123
18	Clare	1,533	5,126	1,065	3,581	1,202	4,102	1,325	4,429	1,459	4,921	1,265	4,188
19	Clinton	938	3,368	1,147	4,031	1,273	4,536	1,397	4,988	1,553	5,498	1,608	5,943
20	Crawford	1,141	3,995	878	2,837	956	3,014	1,046	4,184	1,206	4,638	1,355	4,974
21	Delta	1,313	4,542	1,075	3,623	1,163	4,008	1,256	4,296	1,437	4,893	1,437	4,965
22	Dickinson	1,267	4,150	1,146	3,632	1,232	3,925	1,329	4,291	1,556	4,959	1,544	4,853
23	Eaton	1,064	3,523	1,232	3,956	1,389	4,558	1,490	4,912	1,689	5,515	1,846	6,497
24	Emmet	1,486	5,120	1,052	3,620	1,191	4,168	1,295	4,533	1,417	4,976	1,394	4,694
25	Genesee	1,643	5,705	1,794	6,003	1,975	6,706	1,964	6,667	2,312	7,803	1,904	6,787
26	Gladwin	923	3,247	871	3,117	973	3,580	1,146	4,232	1,227	4,457	1,292	4,824
27	Gogebic	1,282	4,290	1,121	3,625	1,208	3,970	1,299	4,242	1,502	4,913	1,325	4,143
28	Grand Traverse	1,361	5,047	1,132	4,124	1,236	4,609	1,305	4,804	1,470	5,416	1,849	6,827
29	Gratiot	1,251	4,366	1,086	3,674	1,207	4,134	1,335	4,548	1,463	4,960	1,673	5,934
30	Hillsdale	1,079	3,551	1,089	3,474	1,217	3,959	1,366	4,439	1,496	4,804	1,669	5,679

APPENDIX A
Per Capita Disposable Income (2)

#	County	1951		1953		1955		1958		1960		1962	
		Per	Capita Family	Per	Capita Family	Per	Capita Family	Per	Capita Family	Per	Capita Family	Per	Capita Family
31	Houghton	1,579	5,269	993	3,204	1,124	3,705	1,227	4,079	1,301	4,528	1,416	4,638
32	Huron	1,251	4,547	989	3,491	1,122	4,079	1,262	4,623	1,342	4,919	1,327	4,817
33	Ingham	1,799	6,255	1,837	6,158	2,028	6,886	2,026	6,871	2,374	8,078	2,140	7,473
34	Ionia	1,017	3,643	1,045	3,631	1,160	4,096	1,276	4,501	1,417	4,972	1,618	6,113
35	Iosco	1,403	4,554	1,023	3,297	1,177	3,870	1,273	4,516	1,431	4,799	1,532	5,189
36	Iron	1,376	4,563	1,195	3,693	1,314	4,301	1,411	4,680	1,622	5,235	1,522	4,877
37	Isabella	1,313	4,954	1,194	4,339	1,352	5,024	1,458	5,405	1,578	5,857	1,646	6,711
38	Jackson	1,674	5,837	1,510	5,037	1,654	5,649	1,693	5,798	1,895	6,499	2,071	7,359
39	Kalamazoo	1,705	5,839	1,638	5,398	1,796	6,001	1,821	6,077	2,123	7,087	2,175	7,730
40	Kalkaska	954	2,925	770	2,419	866	2,659	1,035	3,763	1,076	3,945	1,263	4,192
41	Kent	1,439	4,827	1,660	5,365	1,823	5,967	1,837	6,015	2,137	7,010	2,097	7,161
42	Keweenaw	844	2,626	893	3,316	1,020	3,499	1,102	4,040	1,158	4,630	1,355	3,844
43	Lake	829	2,440	748	2,201	897	3,591	1,041	3,644	1,231	4,076	1,195	3,506
44	Lapeer	1,017	4,079	1,029	4,011	1,122	4,432	1,216	4,803	1,366	5,324	1,706	6,587
45	Leelanau	829	2,916	1,050	3,554	1,220	4,366	1,364	4,964	1,436	5,399	1,378	4,655
46	Lenawee	1,312	4,510	1,440	4,744	1,572	5,284	1,642	5,523	1,823	6,154	1,721	6,089
47	Livingston	1,345	4,578	1,408	4,650	1,541	5,240	1,606	5,474	1,785	6,027	1,752	6,285
48	Luce	1,298	6,412	843	4,265	934	4,728	996	4,913	1,119	5,458	1,769	8,211
49	Mackinac	1,643	5,597	921	3,106	1,033	3,576	1,136	3,956	1,281	4,547	1,351	5,065
50	Macomb	1,345	4,992	1,610	5,763	1,723	6,254	1,739	5,316	2,055	7,441	1,940	7,408
51	Manistee	1,470	4,764	1,063	3,420	1,150	3,723	1,269	4,119	1,390	4,577	1,590	5,089
52	Marquette	1,408	4,993	1,229	4,219	1,310	4,595	1,367	4,795	1,550	5,377	1,500	5,379
53	Mason	1,423	4,653	1,149	3,621	1,277	4,088	1,402	4,470	1,535	4,916	1,514	4,884
54	Mecosta	1,205	3,958	990	3,191	1,123	3,671	1,283	4,130	1,383	4,443	1,435	5,329
55	Menominee	960	3,394	1,061	3,616	1,183	4,077	1,298	4,518	1,421	4,992	1,323	4,555
56	Midland	1,205	4,374	1,466	5,162	1,509	5,613	1,615	5,805	1,850	6,586	1,955	7,404
57	Missaukee	933	3,566	879	3,180	974	3,570	1,154	4,424	1,251	4,656	1,182	4,149
58	Monroe	1,313	4,701	1,433	4,955	1,536	5,402	1,589	5,604	1,807	6,364	1,702	6,234
59	Montcalm	1,235	3,982	1,178	3,670	1,281	4,064	1,422	4,525	1,566	4,974	1,496	4,904

APPENDIX A
Per Capita Disposable Income (3)

#	County	1951		1953		1955		1958		1960		1962	
		Capita	Family	Capita	Family	Capita	Family	Capita	Family	Capita	Family	Per	Per
		Per		Per		Per		Per		Per		Per	
60	Montrocity	1,470	5,144	866	3,102	1,013	3,716	1,145	4,476	1,264	4,636	1,157	3,685
61	Muskegon	1,535	5,490	1,434	4,754	1,529	5,145	1,573	5,318	1,789	6,022	1,773	6,298
62	Newaygo	892	2,986	1,037	3,398	1,153	3,728	1,297	4,478	1,477	4,835	1,466	5,023
63	Oakland	1,564	5,627	1,816	6,293	2,026	7,112	1,962	6,888	2,352	8,212	2,532	9,276
64	Oceana	969	3,284	891	2,986	1,013	3,477	1,175	4,178	1,259	4,447	1,467	5,082
65	Ogemaw	1,643	5,574	831	2,820	946	3,364	1,091	3,970	1,140	4,254	1,245	4,203
66	Ontonagon	1,095	3,795	839	3,024	1,001	3,487	1,141	3,918	1,258	4,303	1,323	4,495
67	Osceola	985	3,497	849	3,004	966	3,464	1,113	4,143	1,201	4,414	1,390	4,728
68	Oscoda	1,064	3,511	751	2,630	838	3,016	986	3,823	1,058	4,116	1,470	4,362
69	Otsego	1,573	6,039	860	3,287	958	3,606	1,080	4,019	1,186	4,507	1,307	4,624
70	Ottawa	1,454	5,008	1,350	4,503	1,437	4,875	1,511	5,123	1,730	5,823	1,786	6,459
71	Presque Isle	970	3,734	862	3,419	950	3,906	1,077	4,532	1,153	4,909	1,507	5,540
72	Roscommon	1,392	4,176	1,121	3,410	1,279	3,898	1,374	4,311	1,524	4,837	1,555	4,669
73	Saginaw	1,533	5,440	1,508	5,162	1,650	5,715	1,691	5,861	1,869	6,537	1,912	6,556
74	St. Clair	1,470	5,051	1,438	4,750	1,536	5,158	1,599	5,374	1,790	6,001	1,686	5,961
75	St. Joseph	1,403	4,445	1,344	4,111	1,468	4,548	1,558	4,815	1,760	5,466	1,868	6,033
76	Sanilac	1,206	4,217	1,041	3,453	1,195	4,048	1,363	4,563	1,453	4,955	1,415	4,802
77	Schoolcraft	1,026	5,541	989	3,424	1,093	3,892	1,191	4,403	1,367	4,920	1,224	4,151
78	Shiawassee	1,439	4,861	1,397	4,516	1,512	5,013	1,594	5,261	1,776	5,868	1,768	6,144
79	Tuscola	1,220	4,399	1,076	3,777	1,217	4,311	1,342	4,759	1,464	5,147	1,574	5,776
80	Van Buren	1,454	4,520	1,222	3,692	1,377	4,261	1,494	4,625	1,673	5,154	1,659	5,457
81	Washtenaw	1,689	6,479	1,626	6,016	1,796	6,729	1,819	6,813	2,103	7,597	2,432	8,972
82	Wayne	1,977	6,678	1,935	6,627	2,146	7,456	2,053	7,121	2,364	8,174	2,130	7,251
83	Wexford	1,403	4,776	1,113	3,704	1,212	4,094	1,322	4,408	1,434	4,914	1,512	5,097
84	STATE AVERAGE	1,610	5,655	1,641	5,568	1,815	6,248	1,810	6,245	2,224	7,741	2,000	7,011

County Population

#	County	1951	1962	1970	1975	1980
1	Alcona	5,906	6,459	6,907	7,203	7,512
2	Alger	9,931	9,109	8,565	8,241	7,930
3	Allegan	48,517	60,248	71,478	79,536	88,502
4	Alpena	22,826	30,218	37,892	43,647	50,277
5	Antrim	10,686	10,305	10,041	9,879	9,719
6	Arenac	9,666	9,902	10,073	10,183	10,293
7	Baraga	7,948	6,994	6,398	6,051	5,723
8	Barry	26,739	33,097	39,141	43,467	48,272
9	Bay	90,319	111,584	131,763	146,190	162,196
10	Benzie	8,353	7,744	7,394	7,183	6,978
11	Berrien	119,118	158,837	200,425	231,781	268,043
12	Branch	30,672	35,999	40,741	44,017	47,557
13	Calhoun	122,618	143,025	160,985	173,338	186,640
14	Cass	29,060	39,256	50,110	58,372	67,996
15	Charlevoix	13,470	13,409	13,361	13,331	13,301
16	Cheboygan	13,813	14,724	15,442	15,908	16,389
17	Chippewa	29,551	33,429	36,715	38,931	41,290
18	Clare	10,392	11,965	13,326	14,255	15,248
19	Clinton	31,872	39,633	47,056	52,386	58,319
20	Crawford	4,233	5,169	6,043	6,663	7,346
21	Delta	33,052	34,586	35,761	36,516	37,287
22	Dickinson	24,937	23,739	23,042	22,617	22,199
23	Eaton	40,989	52,107	63,039	71,008	79,984
24	Emmet	16,471	15,782	15,305	15,014	14,728
25	Genesee	281,298	403,378	544,031	655,871	790,703
26	Gladwin	9,583	11,069	12,357	13,238	14,182
27	Gogebic	26,785	23,889	22,058	20,985	19,965
28	Grand Traverse	29,087	34,644	39,671	43,177	46,994
29	Gratiot	33,787	37,808	41,164	43,411	45,781
30	Hillsdale	32,199	35,362	37,955	39,670	41,465
31	Houghton	39,359	34,916	32,110	30,472	28,918
32	Huron	33,235	34,182	34,896	35,349	35,808

APPENDIX A

County Population (2)

#	County	1951	1952	1970	1975	1980
33	Ingham	176,777	220,730	263,174	293,710	327,790
34	Ionia	33,655	44,259	49,072	52,343	55,833
35	Iosco	11,466	18,241	27,213	34,945	44,873
36	Iron	17,641	17,034	16,688	16,445	16,205
37	Isabella	29,602	36,919	43,936	48,983	54,611
38	Jackson	110,332	137,946	164,559	183,742	205,161
39	Kalamazoo	131,008	181,413	236,858	279,819	330,571
40	Kalkaska	4,576	4,340	4,175	4,075	3,978
41	Kent	295,782	332,317	469,459	533,742	606,830
42	Keweenaw	2,868	2,334	2,027	1,856	1,700
43	Lake	5,265	5,354	5,418	5,458	5,493
44	Lapeer	36,407	43,371	49,669	54,060	58,841
45	Leelanau	8,114	9,466	10,068	10,464	10,876
46	Lenawee	65,945	80,994	95,192	105,303	116,489
47	Livingston	27,876	41,598	58,296	71,986	88,892
48	Luce	8,115	7,767	7,524	7,376	7,231
49	Mackinac	9,444	11,222	12,828	13,945	15,161
50	Macomb	207,045	508,494	1,253,621	2,203,394	3,872,740
51	Manistee	13,576	19,148	19,577	19,850	20,127
52	Marquette	43,504	58,170	66,983	73,159	79,903
53	Mason	20,620	22,240	23,531	24,376	25,252
54	Mecona	19,176	21,516	23,479	24,796	26,186
55	Menominee	25,233	24,565	24,094	23,804	23,518
56	Midland	37,241	56,109	79,361	98,565	122,415
57	Missaukee	7,391	6,661	6,193	5,917	5,653
58	Monroe	78,211	108,028	140,714	165,993	195,815
59	Montcalm	31,491	36,905	41,700	45,010	48,581
60	Montmorency	4,155	4,487	4,747	4,918	5,095
61	Muskegon	124,385	157,041	188,957	212,122	238,126
62	Newaygo	21,826	24,742	27,215	29,885	30,657
63	Oakland	425,427	736,641	1,413,403	2,022,521	2,994,147

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APPENDIX A
County Population (3)

#	County	1951	1962	1970	1975	1980
64	Oceana	16,149	16,635	16,994	17,223	17,453
65	Ogemaw	9,379	9,748	10,023	10,208	10,391
66	Ontonagon	10,312	10,644	10,890	11,045	11,205
67	Osceola	13,777	13,553	13,335	13,282	13,182
68	Oscoda	3,165	3,515	3,302	3,934	4,195
69	Otsego	6,546	7,005	8,942	9,735	10,600
70	Ottawa	76,248	105,525	137,775	162,762	192,282
71	Prestige Isle	12,108	13,361	14,384	15,363	15,775
72	Roscommon	6,636	7,515	8,919	9,927	11,049
73	Saginaw	157,239	200,134	242,511	273,442	303,317
74	St. Clair	93,159	110,876	126,878	139,032	150,168
75	St. Joseph	35,727	44,102	51,952	57,554	63,761
76	Sanilac	30,935	32,624	33,894	34,713	35,552
77	Schoolcraft	9,127	8,915	8,763	8,668	8,573
78	Shiawassee	45,219	55,202	62,320	68,106	73,839
79	Tuscola	38,763	44,455	49,363	52,710	56,279
80	Van Buren	40,105	50,696	61,045	69,561	77,003
81	Washtenaw	139,309	182,266	227,500	261,309	300,143
82	Wayne	2,459,341	2,717,196	2,930,699	3,072,575	3,221,319
83	Wexford	13,612	18,432	18,296	18,211	18,126
84	STATE TOTAL	6,515,900	8,265,900	10,683,800	13,015,600	16,435,400

APPENDIX 9

TIME SERIES MULTIPLE LINEAR REGRESSION EQUATION RESULTS

APPENDIX B

TIME SERIES MULTIPLE LINEAR REGRESSION EQUATION RESULTS

Code #	County	Inter- Correlation	R ²	a	b ₁	b ₂	TB _{b₁}	TB _{b₂}
1	Alcona	-.070	.846	422.818	-7.642	-.015	-7.888	-.404
2	Alger	.123	.242	235.214	-2.662	.124	-2.041	1.406
3	Allegan	-.784	.252	418.213	-1.240	-.013	-1.608	-.163
4	Alpena	.481	.154	770.763	-6.705	.026	-1.873	.288
5	Antrim	-.712	.956	453.092	-7.134	.038	-10.030	1.229
6	Arenac	.713	.717	266.827	4.636	-.100	4.692	-1.383
7	Baraga	.132	.854	406.336	-13.921	.038	-8.136	1.756
8	Barry	-.985	.747	366.493	-1.814	-.017	-1.147	-1.134
9	Bay	-.637	.210	316.093	-.363	.074	-1.237	.633
10	Benzie	-.170	.811	510.058	-6.622	-.025	-6.998	-.908
11	Berrien	-.813	.132	652.442	-.356	-.127	-1.707	-1.897
12	Branch	-.656	.569	474.318	-2.266	-.060	-4.066	-2.696
13	Calhoun	-.932	.592	492.196	-.638	.005	-1.479	.053
14	Cass	-.922	.208	358.782	-1.109	-.022	-.319	-.283
15	Charlevoix	-.217	.654	611.802	-6.176	-.024	-4.741	-.511
16	Cheboygan	.158	.462	772.308	-7.525	.037	-3.383	.516
17	Chippewa	.134	.237	394.171	-.881	.007	-2.321	.116
18	Clare	.331	.445	342.967	4.201	-.064	3.272	-1.414
19	Clinton	-.909	.800	356.001	-3.462	.029	-2.415	.447
20	Crawford	-.387	.749	602.833	-12.134	-.057	-5.808	-1.301
21	Delta	-.243	.690	446.030	-2.177	.088	-4.529	1.272
22	Dickinson	-.577	.898	697.333	-5.988	.071	-7.334	1.221
23	Eaton	-.952	.433	267.912	-.451	.014	-.723	.276
24	Emmet	-.166	.957	540.850	-2.997	-.034	-15.621	-1.157
25	Genesee	-.140	.145	133.859	-.021	.142	-.157	1.918
26	Gladwin	.944	.737	148.045	2.222	.055	1.523	.386
27	Gogebic	-.013	.519	653.150	-3.051	-.097	-3.611	-.953
28	Grand Traverse	-.616	.795	1,009.494	-6.601	-.122	-6.557	-3.054
29	Gratiot	-.800	.832	505.845	-1.523	-.103	-6.516	-2.958
30	Hillsdale	-.885	.610	206.674	-.665	.049	-1.072	1.028
31	Houghton	-.160	.755	450.646	-1.107	-.009	-5.964	-.350
32	Huron	.730	.394	164.401	2.806	-.148	2.810	-1.287
33	Ingham	-.473	.351	335.850	-.260	.067	-1.550	1.343

APPENDIX B
Time Series Multiple Linear Regression Equation Results (2)

Code #	County	Inter-Correlation	R ²	a	b ₁	b ₂	TS _{b₁}	TS _{b₂}
34	Ionia	-.891	.683	453.141	-1.947	-.055	-3.323	-1.200
35	Iosco	-.174	.569	912.211	-10.626	.044	-3.733	.913
36	Iron	.442	.250	426.790	-3.893	.170	-2.297	1.573
37	Isabella	.863	.631	-.116	2.794	.053	1.737	.531
38	Jackson	-.670	-.055	403.719	-.046	-.047	-.401	-1.134
39	Kalamazoo	-.775	.613	536.785	-.995	.010	-2.672	.144
40	Kalkaska	-.882	.637	403.421	-14.982	-.022	-4.008	-.415
41	Kent	-.889	.351	-64.754	.300	.156	1.167	2.213
42	Keweenaw	-.940	.721	521.326	-18.877	-.039	-2.045	-1.168
43	Lake	-.610	.016	231.375	-4.416	.172	-2.507	3.763
44	Lapeer	-.733	.555	441.439	-2.335	-.041	-3.211	-.773
45	Leelanau	-.824	.636	-115.066	6.009	.177	2.673	4.734
46	Lenawee	-.713	.255	149.743	.550	.055	2.231	.963
47	Livingston							
48	Luce	-.445	.812	394.160	-5.345	.043	-7.034	-2.673
49	MacKineo	.307	.040	879.738	-6.694	-.101	-.744	-.984
50	Macomb	.597	-.161	245.611	.067	.031	.209	.402
51	Manistee	-.805	.919	523.340	-2.433	-.063	-11.144	-2.674
52	Marquette	-.027	.507	576.780	-2.303	.051	-3.557	.705
53	Mason	-.532	.845	513.042	-2.267	-.042	-7.027	-.844
54	Meckata	-.647	.796	332.523	-2.465	.017	-4.728	.554
55	Merominee	-.719	.909	519.236	-4.732	.015	-7.075	.660
56	Midland	-.709	.519	421.892	-1.229	-.019	-2.939	-.423
57	Missaukee	-.105	.823	63.494	-7.401	.253	-2.936	6.435
58	Monroe	-.535	.390	134.029	.471	.056	2.968	.700
59	Montcalm	-.562	.927	269.925	-2.103	.133	3.700	3.208
60	Montmorency	-.170	.536	536.014	-15.669	.000	-3.776	.007
61	Muskegon	-.245	.003	473.843	-.095	-.079	-1.113	-1.130
62	Newaygo	-.620	.876	33.939	-.230	.221	-.239	6.725
63	Oakland	.197	-.159	506.006	-.204	.003	-.692	.223
64	Oceana	-.921	.552	242.670	-1.937	.022	-1.167	.293
65	Ogemaw	-.044	.910	422.186	-2.067	-.013	-10.630	-.933
66	Ontonagon	-.301	.818	565.873	-13.205	.036	-6.276	.717

APPENDIX B
Time Series Multiple Linear Regression Equation Results (3)

Code #	County	Inter-Correlation	R ²	a	b ₁	b ₂	T _{b1}	T _{b2}
67	Oscoda	-.806	.923	411.815	-6.372	.023	-6.357	.583
68	Oscoda	-.727	.463	465.521	-10.554	-.037	-2.659	-.491
69	Otsego	.093	.713	1,822.511	-60.222	-.045	-5.144	-1.261
70	Ottawa	.668	.077	91.690	1.093	-.017	1.382	-.175
71	Presque Isle	.327	.362	490.072	-5.828	.035	-2.253	.939
72	Roscommon	-.295	-.016	903.326	-10.782	.009	-1.110	.409
73	Saginaw	-.516	.372	381.014	-.343	.043	-1.610	1.257
74	St. Clair	-.381	-.043	229.510	-.102	.107	-.559	.816
75	St. Joseph	-.871	.3717	452.073	-1.163	-.041	-2.005	-.699
76	Sanilac	-.558	.866	271.999	-1.233	.004	-5.896	1.856
77	Schoolcraft	.297	.334	525.571	-4.918	-.004	-2.609	-.063
78	Shiawassee	.794	-.163	256.467	.087	.033	.124	.2858
79	Tuscola	-.862	.593	441.473	-1.339	-.058	-2.951	-1.000
80	Van Buren	-.071	.722	1,143.016	-9.319	.117	-4.308	3.149
81	Washtenaw	-.822	.568	617.780	-1.056	-.046	-3.194	-1.202
82	Wayne	-.146	.293	122.737	.010	.130	1.233	2.399
83	Wexford	-.279	.929	1,523.607	-23.372	-.001	-11.504	-.031
84	Michigan	-.597	.053	250.515	.002	.055	.371	1.435

APPENDIX C

CROSS SECTION MULTIPLE LINEAR REGRESSION EQUATION RESULTS

APPENDIX C

CROSS SECTION MULTIPLE LINEAR REGRESSION EQUATION RESULTS

Year	Inter- correlation	R ²	a	b ₁	b ₂	Tb ₁	Tb ₂
1951	.330	.457	46.073	.003	.183	.443	7.80
1952	.379	.130	201.153	.014	.072	1.399	2.722
1953	.430	.157	196.873	.011	.091	.974	3.144
1954	.460	.103	230.153	.013	.067	1.197	2.284
1955	.432	.111	221.953	.013	.069	1.037	2.430
1956	.437	.107	236.462	.014	.073	1.007	2.387
1957	.432	.073	253.007	.015	.059	1.118	1.809
1958	.430	.008	314.419	.019	.006	1.353	.168
1959	.455	-.003	341.662	.019	-.011	1.295	-.331
1960	.465	-.014	333.512	.014	.003	.773	.075
1961	.335	-.007	310.633	.015	.012	.913	.331
1962	.332	-.011	350.179	.016	-.030	.889	-.867

APPENDIX D

SIMPLE CURVILINEAR REGRESSION EQUATION RESULTS

APPENDIX D

SIMPLE CURVILINEAR REGRESSION EQUATION RESULTS

County Code #	Variable ^a	R ²	a	b ₁	b ₂	Tb _{b₁}	Tb _{b₂}
1-33	Food Price Index	.776	418.303	-11.734	.112	-2.004	2.165
1-83	Consumer Price Index	.956	249.159	-6.444	.072	-1.762	2.233
1	4	.597	-30,784,460.00	1,081,709.33	.33	1.7618	-1.6558
	6	.638	703.63	-23.23	.20	-2.9087	2.8105
	7	.748	23,666.17	-841.07	7.76	-3.1426	3.2758
2	4	.852	-51,265,560.00	1,851,396.23	15,660.20	-3.1426	3.2758
	6	.793	-394.96	16.73	.16	1.7411	-1.9137
	7	.276	3,220.13	133.97	.96	.3484	.2818
3	4	.916	135,450,904.00	4,768,804.00	-36,620.70	2.2176	-1.9251
	6	.891	550.60	13.21	.10	-1.4129	1.1560
	7	.947	8,506.03	-301.10	3.08	-2.3702	2.7432
4	4	.964	-31,044,000.00	2,690,559.00	-18,886.13	2.2382	-1.7760
	6	.417	260.47	-6.20	.05	-.9859	.9043
	7	.559	25,402.86	-875.14	7.92	-2.9964	3.0665
5	4	.973	-2,494,544.00	65,806.75	684.33	.2757	.3241
	6	.953	203.05	-5.10	.03	-1.7296	1.3271
	7	.862	12,924.87	-467.76	4.53	-2.2959	2.5134
6	4	.977	4,853,576.00	-182,506.50	2,850.19	-.7641	1.3489
	6	.869	203.83	-3.21	.09	-.9520	1.1837
	7	.620	11,857.60	-416.33	4.00	-1.3272	1.4419
7	4	.913	14,191,976.00	-404,919.00	4,959.14	-2.1867	2.4768
	6	.884	91.53	-2.19	.01	.9668	.7175
	7	.239	28,520.96	-995.12	8.99	-1.8418	1.8798

^aVariable: 4 = Simple projection of gross retail food sales

6 = Number of food stores

7 = Per Capita disposable income

Code #	Variable	R ²	a	b ₁	b ₂	TH _{b₁}	TH _{b₂}
8	4	.961	-4,122,464.00	50,478.00	3,110.20	.0559	.3896
	6	.954	419.01	-10.09	.06	-1.4043	.9944
	7	.974	-146.42	-8.74	.64	-.0753	.6233
9	4	.939	-241,997,056.00	8,644,640.00	-64,924.31	2.3199	-1.9696
	6	.916	1,035.65	-23.42	.16	-1.4127	1.1164
	7	.974	1,672.53	-36.46	.62	-.2596	.4979
10	4	.957	-23,179,744.00	835,681.50	-6,617.83	3.9333	-3.5210
	6	.969	39.27	1.02	-.32	.3735	-.8776
	7	.436	37,973.93	-1,330.46	11.97	-2.7285	2.7743
11	4	.967	-215,834,368.00	7,772,672.00	-51,066.31	1.8906	-1.3967
	6	.992	940.41	-15.83	.07	-2.0831	1.0661
	7	.953	13,372.24	-463.73	4.53	-4.0187	4.4347
12	4	.893	-27,972,200.00	1,063,184.00	-7,014.41	1.0258	-.7651
	6	.972	327.06	-7.71	.05	-1.1671	.9321
	7	.945	23,397.13	-1,013.42	9.54	-5.7430	6.3824
13	4	.930	-74,038,272.00	2,760,440.00	9,447.47	.5035	-.1742
	6	.967	924.50	-19.10	.12	-1.5776	1.0913
	7	.967	-539.43	24.90	.27	.2152	.2634
14	4	.915	-60,637,952.00	2,177,048.00	-16,442.70	2.0015	-1.7095
	6	.870	226.03	-4.59	.03	-1.5532	1.3213
	7	.973	-4,568.43	153.42	-.05	1.4277	-.8934
15	4	.945	-67,312,360.00	2,404,120.00	-19,672.89	4.7112	-4.3579
	6	.940	236.94	-5.61	.04	-1.3743	1.0175
	7	.575	23,814.99	-1,019.17	9.32	-2.5350	2.6215
16	4	.856	-91,840,272.00	3,172,277.50	-25,137.02	2.0621	-1.6471
	6	.823	309.41	-10.41	.03	-1.3157	1.1180
	7	.319	36,096.68	-1,268.39	11.43	-2.1995	2.2399

Code #	variable	R ²	a	b ₁	b ₂	TH b ₁	TH b ₂
17	4 6 7	.963 .852 .190	-136,660,449.00 -96.74 12,478.16	4,885,194.00 10.56 -416.35	-39,652.74 -.13 3.83	5.3075 .5046 -.9594	-4.8699 -.7222 1.0107
18	4 6 7	.972 .620 -.033	-13,822,896.00 261.51 8,274.03	487,044.50 -9.14 -205.32	-2,577.75 .09 2.50	1.3126 -.9784 -.5074	-.7853 1.0959 .5390
19	4 6 7	.968 .963 .911	7,231,104.00 200.32 -4,019.10	-445,837.00 -3.69 135.52	9,167.33 .02 -.72	-.4107 -1.2444 .7223	.8659 .7501 -.4337
20	4 6 7	.929 .994 .830	2,257,712.00 93.93 27,439.32	-94,853.50 -8.50 -971.31	1,054.15 .02 8.03	-.3305 -4.9653 -5.6273	.6633 3.7920 5.8194
21	4 6 7	.852 .964 .729	-72,630,464.00 430.05 17,094.13	-2,553,839.00 -9.21 -501.12	26,830.20 .05 5.43	-1.1709 -1.3960 -2.7311	1.3063 .9333 2.8630
22	4 6 7	.800 .943 .853	-18,863,552.00 274.92 12,916.39	637,453.00 -5.61 -449.22	3,341.32 .04 4.31	.5435 -1.4962 -2.5433	-.2986 1.0411 2.7553
23	4 6 7	.997 .960	221.04 3,094.13	1.43 -152.25	-.02 1.92	-.6903 -1.0303	-.8340 1.4713
24	4 6 7	.975 .333	106.71 10,595.01	2.44 -637.30	-.06 5.03	.2833 -1.6923	-.8479 1.7506
25	4 6 7	.931 .994 .591	2,049.54 -25,110.95	73,903,896.00 -36.29 923.36	643,737.75 .16 -7.93	4.3891 -2.2342 2.6330	-4.0793 1.0323 -2.5425

Code #	Variable	R ²	a	b ₁	b ₂	TS _{b₁}	TS _{b₂}
26	4 6 7	.945 .845 .907	-21,317,840.00 244.64 4,428.77	715,356.00 -9.74 -165.35	-4,984.45 .11 1.86	1.6246 -.8229 -1.0299	-1.2539 1.0341 1.2113
27	4 6 7	.807 .944 .357	-145,818,208.00 313.62 4,147.52	5,363,661.00 -6.51 -123.15	-45,901.01 .04 1.20	4.5965 -2.0953 -.4440	-4.4544 1.3747 .5198
28	4 6 7	.948 1.002 .934	-133,553,536.00 173.88 37,233.01	4,641,184.00 -1.99 -1,325.99	-35,655.64 .00 12.19	2.2747 .0000 -7.1061	-2.4955 .0000 7.3235
29	4 6 7	.969 .998 .938	-73,292,160.00 214.46 20,733.13	2,607,375.00 -2.57 -739.53	-19,617.11 -.02 6.99	3.2994 -1.1439 -4.8093	-2.7984 -.9666 5.1323
30	4 6 7	.923 .894 .981	85,644,480.00 401.14 8,350.32	-3,016,919.00 -11.68 -327.33	29,155.72 .01 3.42	-3.2277 1.2046 -3.5319	3.5261 .9429 4.1689
31	4 6 7	.759 .997 .278	-77,946,400.00 532.3 25,851.71	2,977,754.00 -10.19 -905.14	-23,987.85 .93 8.27	1.7564 -2.5870 -1.5641	-1.5994 .9556 1.6160
32	4 6 7	.989 .604 .531	-108,447,104.00 413.01 9,350.41	3,339,273.00 -16.04 -318.78	-30,490.77 .16 3.08	8.2512 -.8339 -1.0840	-7.4095 .9455 1.1821
33	4 6 7	.980 .965 .742	-519,491,340.01 1,215.99 -11,537.	18,515,328.00 -24.52 437.36	-137,645.75 .15 -3.48	3.9166 -1.4349 1.5132	-3.2914 .9632 -1.3016
34	4 6 7	.977 .923 .982	-82,123,372.00 534.62 11,898.07	2,915,850.00 -13.71 -433.63	-21,994.54 .10 4.32	3.8813 -1.4725 -5.1114	-3.3095 1.1608 5.7614

Code #	Variable	R ²	a	b ₁	b ₂	tb _{b₁}	tb _{b₂}
35	4	.960	-6,403,323.00	9,525.00	3,320.05	.0095	.4297
	6	.881	167.84	-3.39	.02	-1.3301	1.0873
	7	.503	24,791.92	-873.25	8.06	-2.2253	2.3210
36	4	.737	37,390,720.00	1,434,691.00	-12,180.50	2.2859	-2.1199
	6	-.086	323.22	-9.82	.09	-.9324	.9716
	7	.625	5,790.73	-190.60	1.09	-.6709	.7973
37	4	.979	-299,264.00	-139,507.00	5,301.05	-.1553	.6692
	6	.623	295.50	-9.14	.09	-.9799	1.0976
	7	.900	6,636.43	-222.00	2.41	-1.2894	1.5320
38	4	.914	131,306,112.00	-4,307,116.00	49,362.53	-.2912	1.2341
	6	.990	525.67	.05	-.10	.0043	-.9105
	7	.929	19,919.79	-692.70	6.54	-4.4657	4.7656
39	4	.903	-225,241,256.00	6,963,000.00	-33,397.83	1.2949	-.5927
	6	.966	807.63	-16.10	.10	-1.5325	1.0573
	7	.923	11,457.97	-394.09	3.95	-2.2836	2.5092
40	4	.963	-15,417,742.00	556,192.63	-4,590.05	3.1874	-2.9552
	6	.969	100.14	-2.53	.02	-2.8223	2.3217
	7	.827	14,953.80	-542.45	5.20	-2.2714	2.4003
41	4	.992	-937,305,003.01	33,491,103.00	-254,792.13	4.7102	-4.0553
	6	.713	2,520.37	-60.89	.67	-1.1707	1.0260
	7	.932	-9,473.63	343.54	-2.53	1.9794	-1.6391
42	4	.706	-13,997,236.00	496,214.00	-4,110.82	2.7053	-2.5321
	6	.997	43.30	-.60	.03	-.6437	-.1523
	7	.951	2,101.20	-85.99	1.19	-.6985	1.0930
43	4	.934	-10,316,240.00	349,212.00	-2,407.63	1.5205	-1.1095
	6	.625	235.80	-8.62	.07	-1.3051	1.1879
	7	.830	-525.04	.66	.45	.0026	.1993

Code
#

Variable

R²

a

b₁b₂T_{b1}T_{b2}

53	4	.953	-46,426,496.00	1,594,239.00	-10,998.84	1.8189	-1.4174
	6	.956	-11.36	6.64	-.17	.6630	-1.0823
	7	.559	9,762.70	-333.06	3.25	-1.0136	1.1175
54	4	.939	-29,247,936.00	993,856.50	-6,502.15	1.3525	-1.0002
	6	.997	230.81	-4.51	.02	-2.9619	1.4109
	7	.640	5,577.45	-204.74	2.24	-.5239	.6484
55	4	.936	27,637,312.00	-970,239.00	10,657.15	-1.4169	1.7593
	6	.992	193.90	-3.51	.02	-2.4965	1.5283
	7	.830	-11,050.33	302.51	-3.20	2.1049	-1.9107
56	4	.961	-50,586,500.00	1,465,740.00	-5,100.77	.7343	-.2829
	6	.989	93.23	3.12	-.06	.4571	-.9587
	7	.797	4,416.20	-152.10	1.41	-.5216	.7026
57	4	.815	-19,472,756.00	689,394.33	-5,653.93	2.5201	-2.3398
	6	.368	151.64	-4.51	.04	-1.4173	1.3486
	7	.733	74.16	-.70	.32	-.0031	.1565
58	4	.964	-215,791,248.00	7,999,616.00	-64,793.90	5.2513	-4.8080
	6	.993	683.31	-11.69	.83	-3.2929	1.0582
	7	.753	-4,866.19	194.52	-1.42	.9121	-.7525
59	4	.957	-84,849,736.00	2,871,005.00	-20,204.17	2.0690	-1.6692
	6	.843	434.80	-12.23	.09	-1.1968	.9374
	7	.779	-1,496.13	61.29	-.19	.2403	-.0962
60	4	.963	-10,142,736.00	634,402.00	-5,027.26	2.1201	-1.9045
	6	.973	14.11	.64	-.01	.6453	-1.1821
	7	.926	16,006.82	-552.12	5.90	-.8498	.8834
61	4	.951	-29,159,009.01	10,672,804.00	-79,184.83	2.4203	-2.0374
	6	.979	1,909.25	-39.82	.22	-1.6125	1.0021
	7	.774	11,856.45	-394.61	3.75	-2.0372	2.2470

Code #	Variable	R ²	a	b ₁	b ₂	TU _{b₁}	TU _{b₂}
44	4	.933	-93,812,256.00	3,191,049.00	-23,592.53	2.0339	-1.6998
	6	.911	597.12	-12.61	.00	-1.3409	1.0539
	7	.917	25,634.50	-921.95	6.65	-4.5203	4.7921
45	4	.844	-35,022,976.00	1,275,579.25	-10,926.07	4.3656	-4.1884
	6	.903	59.21	-5.51	-.00	-7.9900	-.0216
	7	.940	-21,339.07	751.93	-6.20	4.9236	-4.5963
46	4	.838	-62,944,334.00	2,654,008.00	-19,250.75	1.1402	-.9253
	6	.975	630.00	-14.09	.01	-1.5376	.9735
	7	.895	-12,295.20	449.10	-3.00	2.7612	-2.5959
47	4	.974	-114,037,712.00	3,893,819.00	-20,300.06	3.7339	-3.1875
	6	.923	349.50	-0.37	.00	-1.3315	1.0103
	7	.933	-4,137.70	160.49	-1.65	1.2004	-.9460
48	4	.710	-13,656,352.00	506,872.00	-3,900.90	1.0972	-.9546
	6	.999	50.20	.13	-.01	.2153	-2.5993
	7	.867	64,972.96	-2,219.42	20.00	-6.5721	6.7134
49	4	.901	-172,567,072.00	6,162,097.00	-53,065.73	7.2953	-7.1045
	6	.599	212.67	-5.30	.64	-1.2002	1.1407
	7	.220	33,559.65	-1,349.20	12.10	-2.3792	2.4140
50	4	.986	-506,302,576.00	12,006,464.00	-14,625.00	.8065	-.1193
	6	.939	245.36	.41	.05	.0021	10.9413
	7	.773	-8,663.93	324.21	-2.67	1.1945	-1.0273
51	4	.947	-35,620,208.00	1,230,708.50	-8,359.02	1.0535	-1.2753
	6	.985	27.40	4.95	-.03	2.7463	-5.0264
	7	.756	32,864.73	-1,156.43	10.94	-3.9359	4.1057
52	4	.938	-51,340,864.00	1,795,212.00	-9,313.16	.6656	-.4021
	6	.923	200.00	-3.00	.02	-2.2500	1.2157
	7	.635	11,244.50	-372.77	9.20	-1.6711	1.9906

Code #	variable	R ²	a	b ₁	b ₂	TB _{b₁}	TB _{b₂}
62	4	.993	-44,489,536.00	1,509,409.00	-10,595.87	3.2753	-2.5993
	6	.957	343.92	-9.59	.03	-1.0357	.9633
	7	.950	-4,057.59	135.31	.74	1.1323	-.7012
63	4	.994		73,994,656.00	567,772.00	5.9492	-4.8336
	6	.267	2,393.56	-61.40	.51	-.9757	1.0353
	7	.834	5,659.95	-204.21	2.47	-.7100	.9716
64	4	.923	11,251,216.00	-252,536.57	4,370.52	-.8053	1.1291
	6	.805	-27.36	3.93	-.85	.0119	-.8406
	7	.953	13,657.51	-520.16	4.90	-1.5974	3.9374
65	4	.954	8,993,603.00	-369,137.00	4,707.15	-.7683	1.1353
	6	.931	122.44	.52	-.94	.1203	-1.0493
	7	.213	39,120.94	-1,363.32	12.25	-2.0365	2.0617
66	4	.944	-43,932,904.00	1,707,756.75	-13,307.57	4.3091	-3.9555
	6	.757	192.46	-5.31	.04	-1.3229	1.2242
	7	.776	12,163.71	-434.37	4.20	-1.7473	1.9117
67	4	.941	4,878,664.00	-205,545.00	3,184.57	-.4771	.9356
	6	.932	156.43	-3.13	.92	-1.7795	1.1132
	7	.924	15,595.32	-565.31	5.43	-3.4596	3.7526
68	4	.914	3,600,740.00	-147,154.25	1,322.59	-.4763	.6676
	6	.935	-45.75	3.02	-.93	.9273	-1.0770
	7	.931	35,640.43	-1,236.95	11.93	-3.9459	4.1164
69	4	.922	-39,619,323.00	1,385,747.00	-10,904.73	2.7480	-2.4445
	6	.957	62.63	-1.27	.91	-3.4634	3.0439
	7	.419	42,217.25	-1,478.33	12.24	-2.8616	2.9964
70	4	.972	-146,663,630.00	4,739,524.00	-23,303.59	1.7329	-1.2543
	6	.927	704.73	-13.92	.19	-.9234	.9366
	7	.930	15,854.36	-543.66	5.20	-4.3253	4.6306

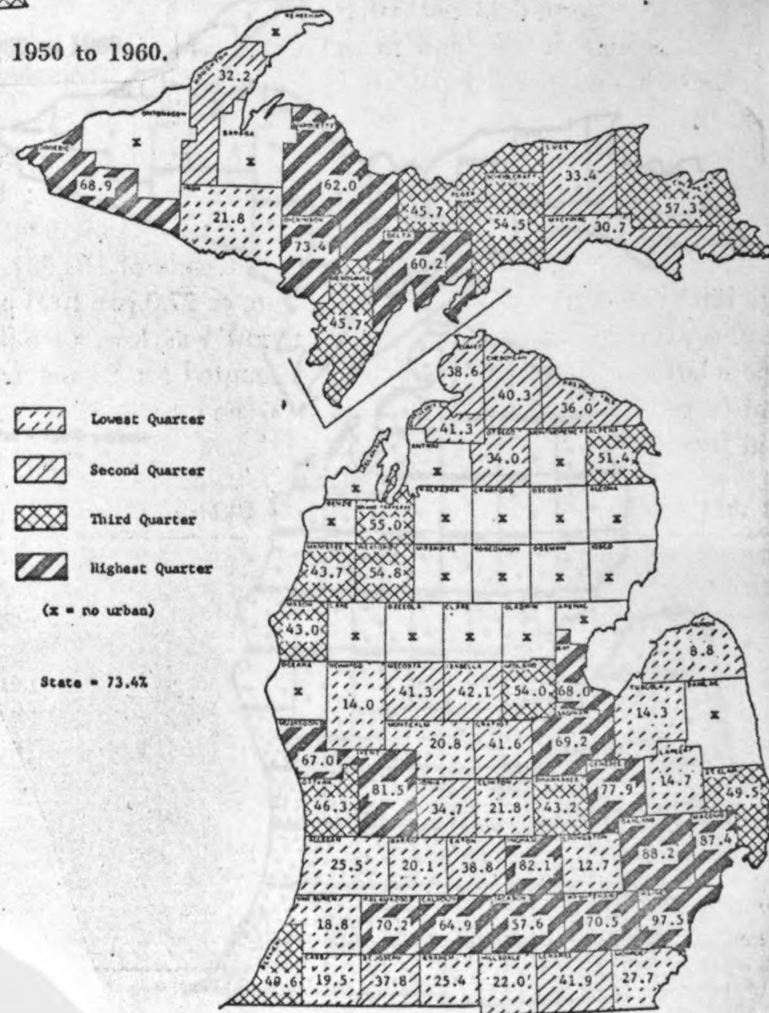
Code #	Variable	R ²	a	b ₁	b ₂	T _{b1}	T _{b2}
71	4 6 7	.953 .362 .931	-20,547,152.00 188.75 27,290.21	736,237.00 -4.90 -930.33	-5,258.93 .04 9.11	2.2359 -1.0325 -5.7663	-1.8089 .9597 6.0559
72	4 6 7	.971 .635 .563	-61,223,043.00 220.97 7,712.70	2,199,926.00 -5.43 -271.19	-17,920.01 .04 2.79	5.9243 -1.0621 -6.6629	-5.4325 .9239 .7703
73	4 6 7	.934 .913 .573	-513,200,443.01 837.25 -663.17	18,303,603.00 -23.63 432.54	-139,600.04 .20 -3.39	4.9030 -1.3254 .9640	-4.3023 1.0343 -.8552
74	4 6 7	.961 .999 .742	-417,462,656.01 837.25 -663.17	15,150,500.00 -12.13 50.12	-124,105.56 .02 -.13	5.6411 -5.2269 .2068	-5.2213 .9521 -.1102
75	4 6 7	.969 .999 .941	-11,309,563.00 305.11 10,923.73	432,723.00 -5.03 -332.63	437.14 .02 -.13	.4515 -6.5221 -2.5433	-.0516 2.7250 2.9011
76	4 6 7	.953 .970 .643	-26,037,392.00 -195.03 2,447.23	869,810.00 13.94 -32.04	-4,355.26 -.16 1.03	.9337 1.5334 -.2639	-.5235 -2.7933 .3909
77	4 6 7	.752 .909 .081	-53,935,072.00 153.81 25,662.41	1,965,610.00 -3.51 -876.62	-10,563.05 .02 7.02	2.9547 -2.2233 -1.6357	-2.8145 1.3615 1.6433
78	4 6 7	.952 .701 .890	-53,431,104.00 474.32 3,836.61	1,960,036.00 -15.62 -122.61	-12,455.08 .15 1.44	1.6024 -.8395 -.7843	-1.1510 .9799 1.0405
79	4 6 7	.970 .973 .890	-53,133,392.00 113.87 11,402.22	2,069,674.00 2.71 -405.73	-14,761.57 -.05 4.00	2.7371 .4208 -2.1822	-2.2023 -.9559 2.4323

Code #	Variable	R ²	a	b ₁	b ₂	TR b ₁	TR b ₂
80	4	.986	-34,223,360.00	970,066.00	-1,053.02	.8339	-.1023
	6	.330	250.73	-4.91	.04	-1.0072	.9360
	7	.689	8,316.32	-289.03	2.34	-.8959	1.0320
81	4	.261	-245,792,512.00	6,154,712.00	-47,230.73	1.2900	-.8493
	6	.994	644.91	-10.43	.04	-2.0972	.9542
	7	.899	21,743.41	-782.29	7.59	-2.6626	2.0219
82	4	.823	-13,042.51	490.84	-4.21	6.6530	-6.4513
	6	.996	21,504.53	-357.61	1.41	-2.4558	1.0684
	7	.643	-16,676.96	702.76	-5.92	2.3164	-2.2043
83	4	.263	-11,216,976.00	493,027.00	-1,509.24	.7935	-.3318
	6	1.002	73.10	-.53	.00	.0000	.0000
	7	.693	19,073.76	-661.16	6.11	-2.6410	2.7603
State	4	.290	6,723,224.00	-132,704.00	2,537.45	-2.1576	4.6473
	6	.617	-13,825.55	405.23	-3.95	.9762	-.8589
	7	.985	249.16	-6.44	.07	-1.7624	2.2323

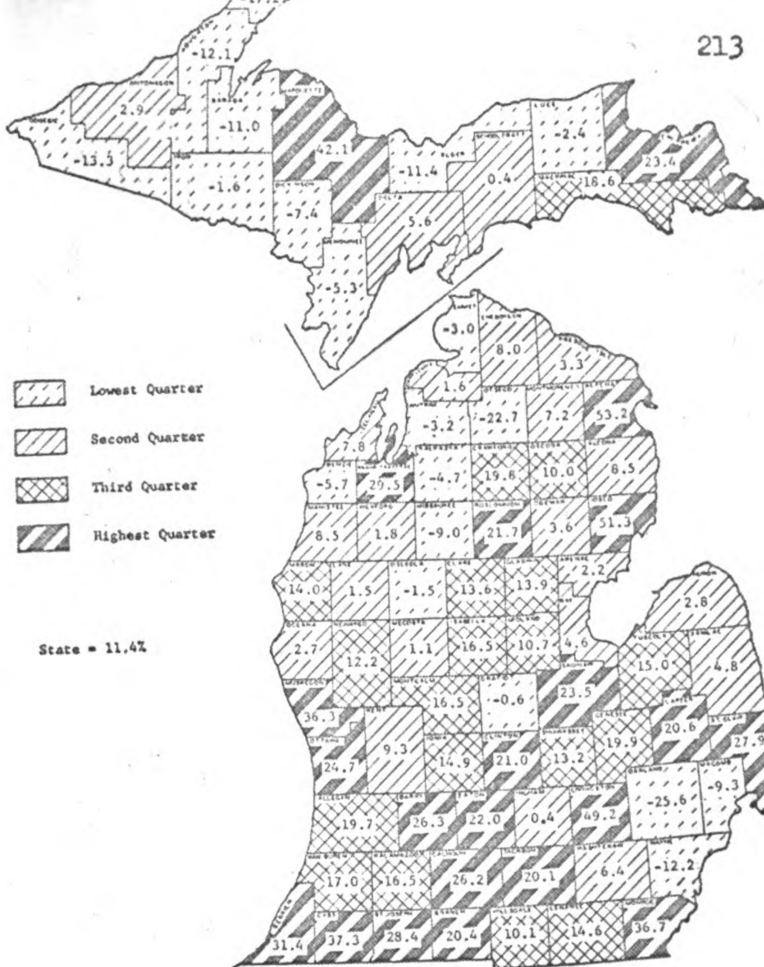
APPENDIX 2
MICHIGAN POPULATION TRENDS



Percent change in urban population, by county, 1950 to 1960.



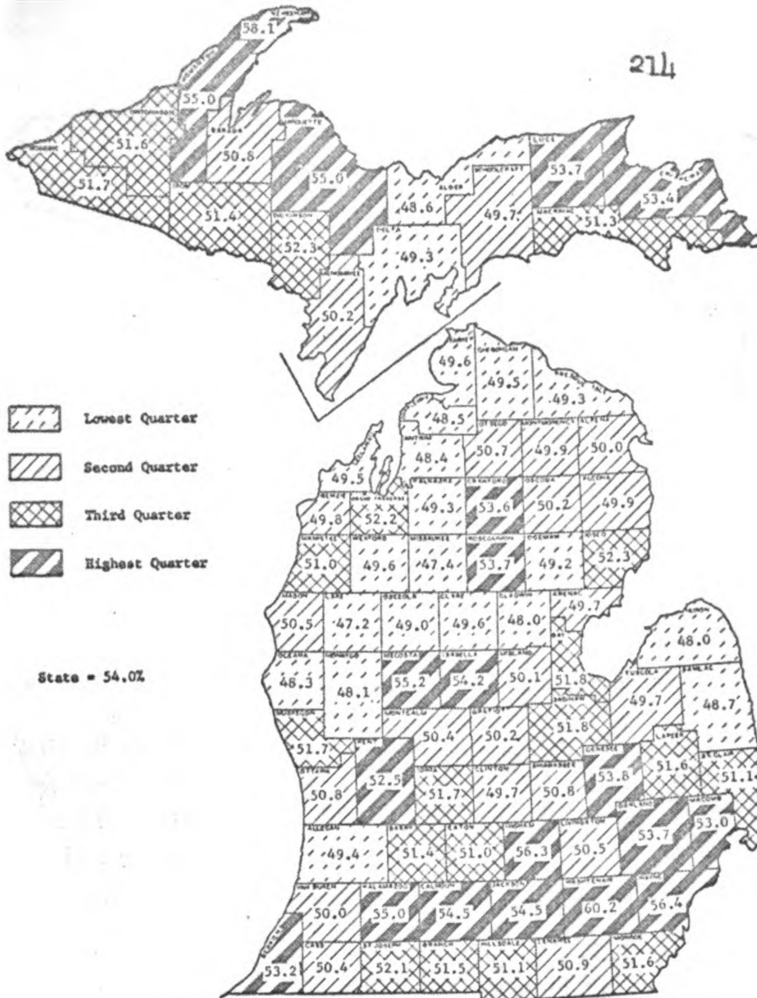
Percent of total population urban, by county, 1960.



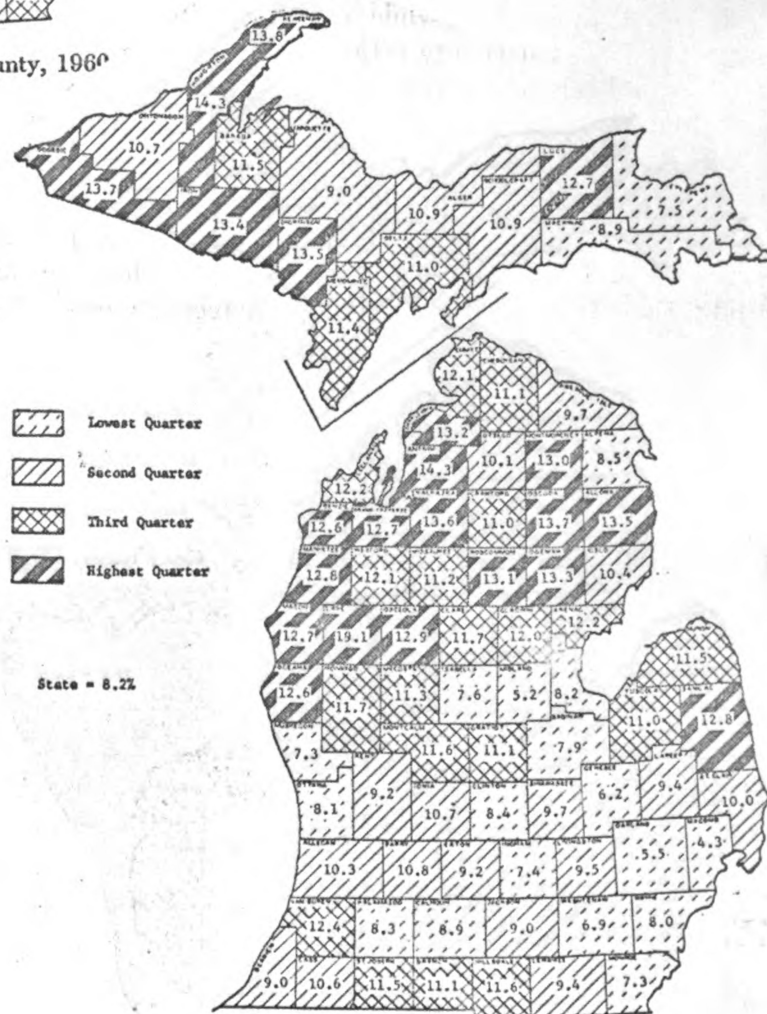
Percent change in rural population, by county, 1950 to 1960.



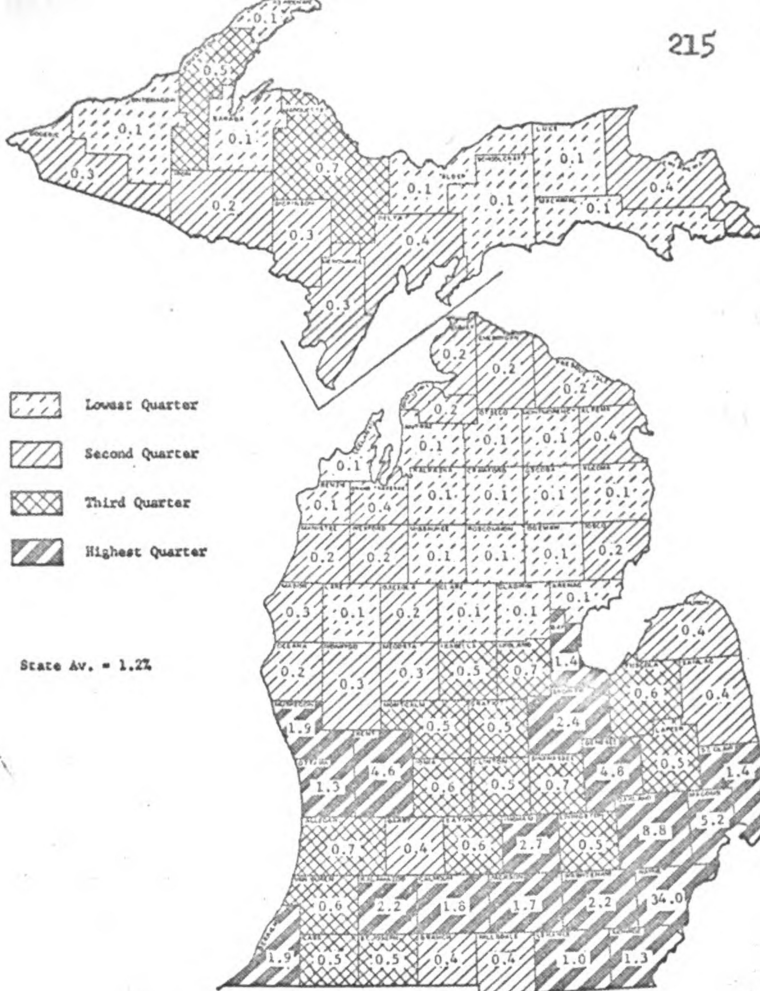
Distribution of rural population outside places of 1000 to 2500 by county, 1960



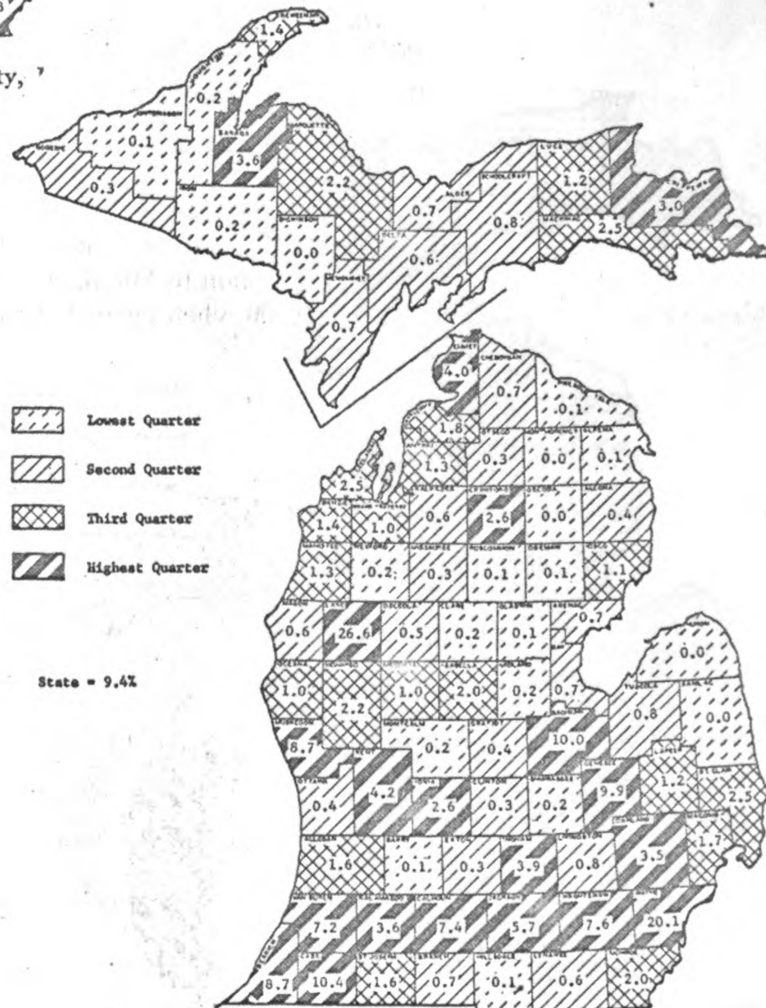
Percent 18 to 64 years of age, by county, 1960



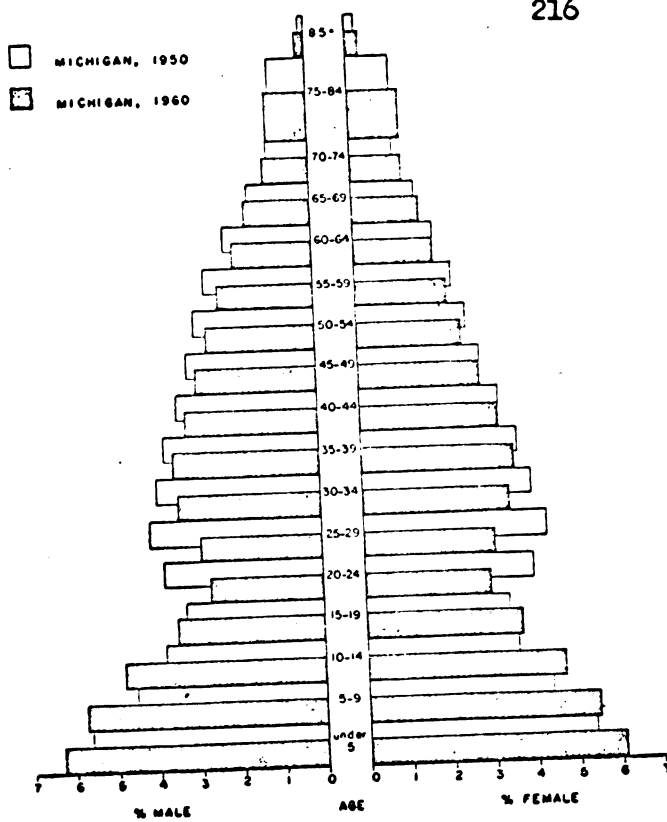
Percent 65 years of age and over, by county, 1960



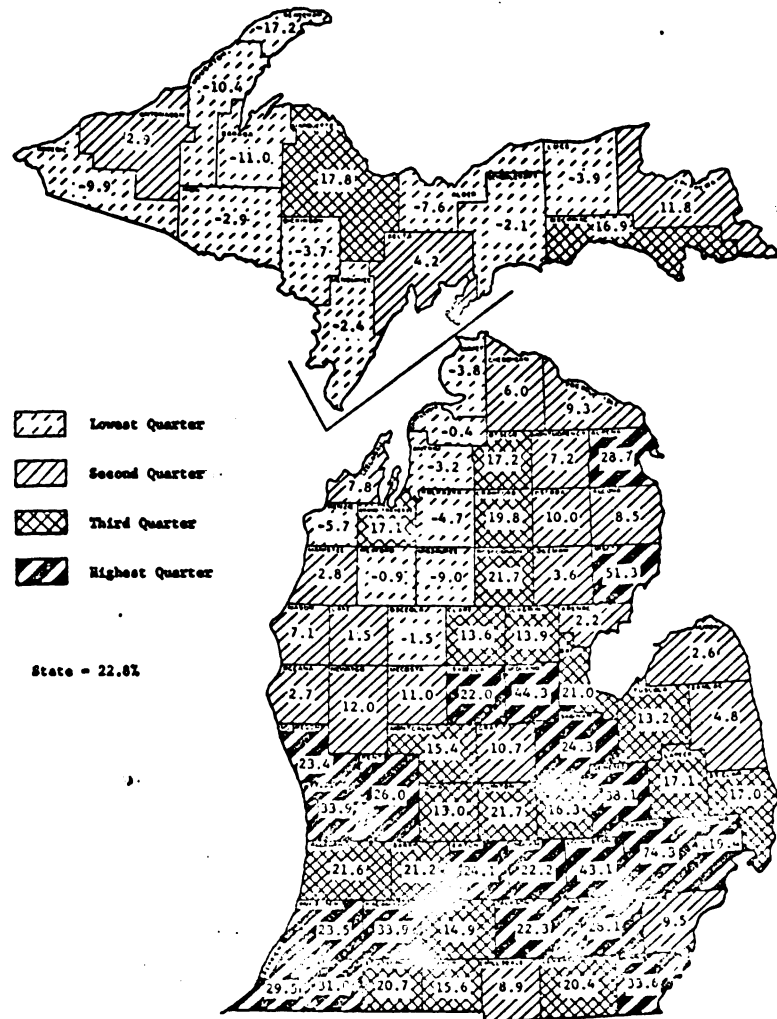
Percent of total state populations, by county, '7

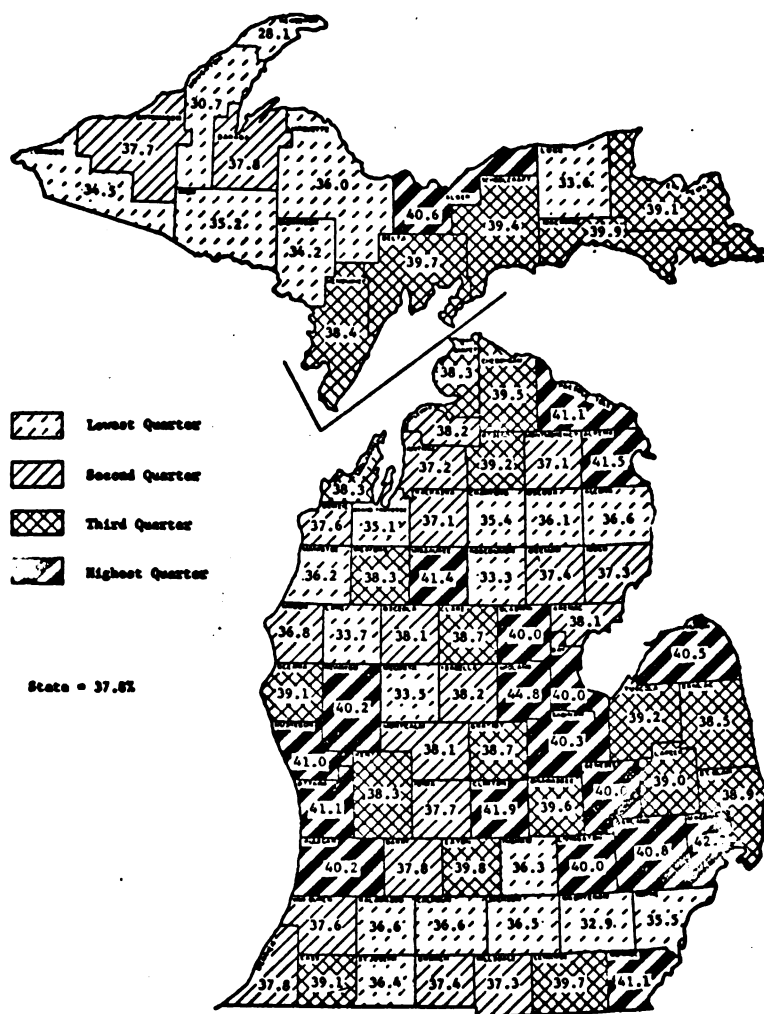


Percent nonwhites, by county, 1960.



Age-sex pyramid for Michigan, 1950 and 1960.





Percent under 18 years of age, by county, 1960.

APPENDIX F

MICHIGAN COUNTY CODE NUMBERS



ROOM USE ONLY

10-11-68