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Statistical analysis of farm land values in Jefferson County, Tennessee

Charles Daniel Mounger Jr.

To the Graduate Council:

I am submitting herewith a thesis written by Charles Daniel Mounger Jr. entitled "Statistical analysis of farm land values in Jefferson County, Tennessee." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

W. P. Ranney, Major Professor

We have read this thesis and recommend its acceptance:

Donald G. Paris, A.J. Garbarino, J. T. Miles

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

December 6, 1960

To the Graduate Council:

I am submitting herewith a thesis written by Charles Daniel Mounger, Jr. entitled "Statistical Analysis of Farm Land Values in Jefferson County, Tennessee." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

W. P. Ranney
Major Professor

We have read this thesis
and recommend its acceptance:

Donald G Paris

A. J. Garbarino

J. T. Miles

Accepted for the Council:

H. E. Spivey
Acting Dean of the Graduate School

STATISTICAL ANALYSIS OF FARM LAND VALUES
IN JEFFERSON COUNTY, TENNESSEE

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

Charles Daniel Mounger, Jr.

December 1960

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CHAPTER I

INTRODUCTION

It is generally recognized that a great deal of variability exists in farm land prices. Persons involved in making predictions of farm land prices make them for different reasons. Some predictions are made for loan purposes, while others are made for the market value. When predictions of market value are not in agreement with the actual sale price the predictive system has failed to explain the variability present in farm land prices. The income capitalization method and the comparative method are examples of two popular predictive systems. Income capitalization fails to explain variability in prices of farm land in areas having a heterogeneous cross section of income sources. The comparative method, likewise, encounters difficulty in predicting when the physical assets and surroundings are heterogeneous.

This variability in farm land prices calls for an explanation. The intent of this thesis was to provide an explanation of this observed variability. An explanation was defined and used as the degree of association which existed between variables which could be used for predictions. The specific objectives are: (1) to isolate variables that can be measured and used as "explainers" of variability in farm land prices, (2) to use least squares regression techniques in estimating parameters for relevant variables included in a predicting equation, and (3) to present the techniques used in selecting explanatory variables.

Economic theory has advanced two concepts that purport to explain differences in prices paid for farms. These are productivity theory and indifference theory. Both concepts, along with a discussion of the imperfection in the land market, are presented in Chapter II to show the difficulty of their application. Most researchers in the past have made indirect use of these concepts in attempting to explain variability in land prices. Certain statistical problems are encountered in using the methods employed by past researchers. These will also be discussed in Chapter II.

In the absence of verified theory the accomplishment of the first two objectives becomes difficult. Therefore, the statistical procedure necessary to reach these objectives is critical. When parameters are estimated by least squares regression techniques, parameters are obtained for each variable in the equation. However, an error term, the residual, is also obtained. This error may be caused by error in the selection of the form of the algebraic equation and/or by excluded variables. The intention of this thesis was to select a combination of independent variables for a linear equation which gave the smallest error term or the "best fit."[1] Those variables which gave the "best fit" were considered as the explainers of variability in farm land prices.

Chapter III is used to discuss the possible independent variables selected for this study. A description of the continuous and discontinuous variables, their measurement units, and how they were obtained will be given. A discussion of the survey area, the qualification of the respondents, and the interview procedures will also be presented.

Chapter IV is devoted to a discussion of the use of continuous variables in linear equations. Simple regression expresses the simple relation-

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[1]It is recognized that another form of algebraic equation might give a better fit for the same combination of variables; however, other equations were not fitted due to difficulties involved in hand calculation.

ship between an independent variable and the dependent variable. The writer points out that a simple regression equation explains a small portion of the variability in the dependent variable. As previously pointed out, this error may be due to an error in selecting the form of the algebraic equation and excluding relevant variables. There will be a discussion of the methods of reducing the error by the selection of the correct algebraic form of the equation and by the inclusion of additional independent variables. Different combinations of independent variables will be analyzed in an attempt to explain the variability of farm land prices.

Biserial correlation is used to express the degree of association of changes in the dependent variable with changes in a discontinuous independent variable in Chapter V. The relevant discontinuous independent variables will be chosen and procedures for including them in a multiple regression are shown in Chapter V. Finally, in Chapter VI, a summary of the analysis is presented and followed by the conclusions of this thesis.

CHAPTER II

CONCEPTUAL PROBLEMS AND STATISTICAL TECHNIQUES OF ESTIMATING LAND VALUES

Two concepts have been advanced in economic theory that purport to explain differences in prices paid for farms. The first of these concepts is resource productivity theory. The usual procedure has been to attempt to explain at least part of the variability in land prices by differences in soil capabilities, soil uses, and subsidence patterns. The second concept is indifference analysis. The usual procedure here has been to explain variability in land prices by variation in responses to questions believed to reflect differences in tastes and preferences. Imperfections in the market for land and difficulty in specifying the relevant production and indifference relationships renders an empirical interpretation of these concepts exceedingly difficult. The problem of an imperfect market is discussed in the succeeding section. Next, difficulties in describing the production and indifference relationships will be discussed. Finally, alternative statistical methods used in attempting to explain variability in land prices using specific "explanatory" variables will be presented.

I. IMPERFECTIONS IN THE MARKET

Imperfections in the market for farm land prices arise from: (1) lack of knowledge on the part of both buyers and sellers, (2) indivisibility of assets, and (3) strategies in bargaining. There is no central land market (such as the grain market) where land can be sold. If the buyer does not see the tract, he buys by description and the description of property is limited due to the lack of a standard of comparison. If a central land market existed, all prospective buyers and sellers could meet and bid against each other and determine price. In effect, there is no workable system in operation to distribute information among all prospective buyers and sellers as to the items potentially available for sale. Another factor leading to imperfections in the land market is the indivisibility of assets, i.e., a farm is usually sold as a unit and not as individual parts such as buildings, water, other rights, and privileges; therefore the price determining operation of the market tends to be ineffective in establishing specific prices for these parts.

To further complicate the picture, the buyers and sellers may use bargaining strategies. Each buyer and seller may be trying to obtain the optimum benefit of the sale, and therefore tends to offer a price that may be different from the price he is willing to give or accept. He may do this with the expectation of getting a better price at the expense of the other party, but at the same time he may not offer a price that will discourage the other party from bargaining. Therefore the actual sale price may be determined by the relative bargaining ability of the buyer and seller.[1]

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[1]Game theory will provide optimum solutions or strategies for the buyer and seller. But, to use game theory to explain variability in land prices would require quantification of the strategies. The following publication demonstrates a technique for determining strategies in farmer purchases of machinery: Albert N. Halter and John W. Hubbard, Farmer's Use of Strategies in Machinery Trades, Kentucky Agricultural Experiment Station Progress Report 83 (Lexington: Kentucky Agricultural Experiment Station, 1959).

II. SPECIFICATION OF DESCRIPTIVE RELATIONSHIPS

An empirical interpretation of the production process or the indifference phenomenon would involve: (1) specification of relevant variables and (2) specification of appropriate algebraic equations that would be descriptive of the process or phenomenon. The difficulties of applying these two concepts to explain variability in land prices becomes apparent. The only check on the adequacy of the specification of variables and equations would be the agreement of the deduced solution; that is, predicted land prices with observed prices. An explicit assumption of these concepts is that technology, in the case of production, and tastes or preferences, in the case of indifference analysis, remain the same.[2] From the practical standpoint we do know that technology and tastes or preferences change. Hence, a continual revision of the descriptive relationship would be necessary to predict or explain the variability in land prices.

III. ALTERNATIVE STATISTICAL APPROACHES TO ESTIMATING LAND PRICES

Productivity analysis and indifference analysis in their "pure form" are impractical to apply. Thus, researchers in the field of land value have simply sought to isolate factors thatwere associated with farm real estate value. The key to this research has been specification of the most important or influential variables. Statistical methods used for measuring the influence of various variables have generally followed two techniques:

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[2]The writer recognizes the limitation to making interpersonal comparison of tastes and preferences.

(1) tabulation (averages and cross classification) and (2) regression (simple and multiple regression). The type of variable, either continuous or discontinuous has indicated the statistical technique to be used in analyzing the data. Each technique has advantages and limitations in its use. An example of each statistical technique will be shown and discussed in subsequent subsections.

Tabular Analysis

Tabular analysis has been a popular tool for analyzing data for study of variables that influence land prices. The procedure may be better known as cross classification and averaging. An example of the use of cross classification is shown in Table I. There were two independent variables which were believed to influence the price per acre. These independent variables were: (1) type of road and (2) distance to market. The dependent variable was average price received for farms falling within a given distance interval to market and on a certain type of road. For example, land 0 to 2.5 miles from a market and on a dirt road showed an average value per acre of $160.00. The average value per acre for farms on dirt roads decreased $5.00 per acre when the distance to market was increased one class interval. This cross classification attempts to measure the change in the dependent variable when one of the independent variables changes while the other remains fixed.

The main advantages of cross tabulation are that it is rather simple and can be used when non-quantitative variables are believed to explain the dependent variable. The main disadvantages of cross classification are: (1) the large number of cases required for conclusive results and (2) it provides no measure of the strength of the relationship between variables

TABLE I

CROSS TABULATION ON BASIS OF STATE AND DIRT ROADS AND DISTANCE TO MARKET (MILES)[a]

Dirt Roads			State Roads		
Distance to market	Value per acre	Acres	Distance to market	Value per acre	Acres
0- 2.5	$160	2,546	0- 2.5	$180	1,498
2.5- 4.5	155	4,104	2.5- 4.5	173	2,309
4.5- 6.5	133	2,161	4.5- 6.5	203	210
6.5- 8.5	131	1,352	6.5- 8.5	138	712
8.5-10.5	127	155	8.5-10.5	189	40
10.5-12.5	78	75	10.5-12.5	169	102

[a]Source: G. C. Haas, Sale Prices as a Basis for Farm Land Appraisal, University of Minnesota Experiment Station, Technical Bulletin 9, November, 1952, p. 16.

under observation; hence, a predicting relationship cannot be obtained. (However drift lines can be constructed that at least show a general tendency.)

Regression Analysis

The use of statistical regression techniques tends to avoid some of the problems of cross classification; such as computing predicting equations and analysis of continuous variables that are not provided for by the use of tabulation. The regression technique expresses the relationship of the dependent variable with one or more independent variables.[3]

An example of how regression has been used to study the factors influencing land values can be found in Table II. An equation of the form $Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + U$ was fitted to the data where:

Y denoted value of the farm,

X_1 denoted acres of flue-cured tobacco allotment,

X_2 denoted acres of cropland,

X_3 denoted value of buildings,

X_4 denoted acres of non cropland, and

U denoted errors from specification of the form of the equation and excluded variables.

This linear equation was fitted to data from three areas of Virginia and North Carolina. Each of the regression coefficients (b_i) reflects the amount of change in the dependent variable expected as a result of a one unit change in the independent variable while all other independent variables

[3]A discussion of least squares technique will not be given here since this is not the intent of this thesis.

TABLE II

RESULTS OF MULTIPLE REGRESSIONS FOR YEARS COMBINED, AREAS STUDIED

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4$$ [a]

Area	Number of observations	Coefficient of multiple determination R^2	Intercept a	Partial regression coefficients: Acres of tobacco allotment b_1	Acres of cropland b_2	Value of buildings b_3	Acres of non-cropland b_4
Pittsylvania	213	0.74** ($3,281)	$ 183	$1,017** (150)	$ 30.23* (13.00)	$1.03** (0.11)	$ 6.30 (4.37)
Greene, Wilson and Pitt	129	0.74** ($5,616)	2,938	1,782** (311)	47.72 (49.83)	0.41** (0.13)	19.97 (19.97)
Forsyth and Guilford	76	0.78** (2,711)	543	- 156 (264)	154.27** (35.44)	0.79** (0.11)	63.45** (18.84)

**Statistically significant at the 1% level of probability.
*Statistically significant at the 5% level of probability.

The values in parenthesis: (a) In the column of the coefficients of multiple determination indicate the respective standard errors of the estimates of Y, and (b) in the columns of the partial regression coefficients indicate the respective standard errors of the estimates of the b_1.

[a]Source: Frank H. Maier, James L. Hedrick, and W. L. Gibson Jr. The Sale Value of Flue-Cured Tobacco Allotments, Virginia Polytechnic Institute, Agricultural Experiment Station Technical Bulletin No. 148, April, 1960, p. 25.

are held constant. For example, an increase of one acre of tobacco allotment in the first area with all other X_i held fixed would predict an increase of $1017.00 in the price of the farm. A standard error can be computed for each regression coefficient which provides a measure of reliability of a given coefficient (Table II). In addition, regression technique provides a measure of the "goodness of fit" obtained for a specific equation. The "goodness of fit" is referred to as the coefficient of multiple determination which expresses the per cent of the total variation in the dependent variable that is explained by the variations in the independent variable.

The least square regression technique can be very useful in observing continuous variables. It allows the researcher to: (1) consider the relationships between a dependent variable and several independent variables simultaneously, and (2) attach probabilities to statements concerning the "goodness of fit" or reliability of the regression coefficients.[4] However, certain problems often arise in connection with regression analysis. These are: (1) spurious results can be obtained, i.e., the results are only as good as the logic in conceptualizing the equation, (2) large intercorrelations between the independent variables tend to increase the variability of the regression coefficients, and (3) intercorrelations among independent variables make it difficult to interpret the regression coefficients.

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[4]These statements can only be made when the data conform to a set of rigid assumptions.

CHAPTER III

MEASUREMENT OF VARIABLES BELIEVED TO EXPLAIN VARIABILITY IN LAND VALUES

The concept of a production or an indifference surface was discussed in the preceding chapter as possible "explainers" of variation in land values. However, it was pointed out that the variables and equations necessary for an empirical interpretation of these concepts would be difficult to acquire. Work in previous studies have reflected attempts to isolate variables that could be used in simple explaining models. This study was also concerned with specifying simple equations and variables to "explain" variability in land values. Before these simple equations could be used, it was necessary to: (1) specify and measure variables believed to "explain" some variability in land prices and (2) acquire the data. The first section of this chapter is devoted to a discussion of possible variables, and the second section is concerned with acquisition of the data.

I. POSSIBLE VARIABLES

The variables selected for this study were, in general, the same types of variables used in previous studies. However, variables that were found to have no influence on farm land value in other studies were not considered. Some new variables were added with the intention of explaining more of the variation in land values. For example, some studies used total improvements as one of the independent variables whereas a component breakdown of total improvements was obtained for this thesis. The dependent variable for this thesis was sale price per acre. Five general categories of independent variables specified for measurement were: (1) improvements, (2) roads, (3) location, (4) natural physical characteristics, and (5) others. Some of the specific variables measured under each of the five general categories were continuous variables whereas others were discontinuous. The continuous and discontinuous variables will be discussed in the next two sections.

Continuous Variables

Continuous variables were those in which an arithmetic number could be used to express the magnitude of the variable over a large range of numbers. The units in which each specific variable within a category was expressed varied. The categories were expressed as follows: (1) improvements in dollars, (2) roads in feet, (3) location with reference to highways in miles, (4) natural physical characteristics in per cent, and (5) others either in per cent or acres. The dependent variable, price per acre, was expressed in dollars.

Improvements. The improvement category consisted of man-made objects which were subject to depreciation. This category included: (1) value of main dwelling per acre, (2) value of main dwelling per farm, (3) value of main barn, (4) value of other barns, (5) value of total improvements, (6) value of total improvements per acre, and (7) value of total improvements minus the value of the main dwelling. The total improvement category was the sum of the dollar values of all dwellings, barns, silos, milking houses, tool sheds, chicken houses, hog houses, pump houses, other buildings, and fences. Total improvements per acre was obtained by dividing the value of the total improvements by the number of acres in the farm.

Pricing the items included in these categories was exceedingly difficult and subject to judgement errors. An estimation of the value of each of the specific variables classed as improvements was obtained by using the owner's estimates, the enumerator's estimates, and an appraisal library of the United States Department of Internal Revenue.[1] Each respondent was asked to value each item at the date on which he bought the farm.[2]

There were five ways in which each of these estimates could agree. First, when the farmer's and the enumerator's estimates agreed rather closely, the farmer's estimate was used as the value of that item. Second, when the farmer's estimate and the estimate made from the tax reference agreed reasonably well, the farmer's estimate was used. Third, when the enumerator's estimate and an estimate from the tax reference were about the same, the enumerator's estimate was used. Fourth, when no agreement was found between the three estimates, the enumerator, who had considerable experience in appraisal, referred these estimates to a local realtor who made an independent estimate. The estimate chosen for the value of that item on that particular farm was the estimate that most closely agreed with the local realtor's estimate. Fifth, when all three estimates were about the same, the farmer's estimate was used. In general, all three estimates were about the same. (The tax reference served as a guide, but the farmer's

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[1]The reference library of the Department of Internal Revenue is a composition of various tables, photographs, sketches, and formula collected in bulk form and used by some of the Internal Revenue Agents as references. No specific reference can be given as to name or content because the content is continually changed by the addition of articles, notes, and references.

[2]All farms contained in this study were purchased in a two year period; therefore, the maximum time lapse was twenty-five and one half months from the date of the sale to the date of the enumeration. The schedules were completed prior to August 15, 1957.

estimate was most useful since it probably expressed the decision price of the items.)

Roads. One variable was considered under the general road category. This variable was the amount of road frontage expressed in feet. Road frontage was defined as the number of feet of farm land that bordered on a public road.[3] Road frontage was obtained by measurements from aerial photographs and maps. In cases where neither photographs nor maps were available, a measurement was obtained from a sketch based on the adjusted deed description.

Location. The category of locational variables consisted of distance to two lane highways and distance to a four lane highway. Distance was defined as the miles the farmer normally drove until he reached a specified class of highway.[4]

Natural physical characteristics of land. The category of variables denoted as natural physical characteristics of land included the physiography and land use of the tracts in question. These variables included: (1) a soil index, (2) per cent of class I soil, (3) per cent of class II soil, (4) per cent of class III soil, (5) per cent of class IV soil, (6) per cent of class V soil, (7) per cent of farm in improved pastures, (8) per cent of farm in unimproved pastures, (9) per cent of land less than 2000 feet of water, (10) per cent of land between 500 and 2000 feet of water, (11) per

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[3]The type of road frontage will be discussed under the section on discontinuous variables.

[4]Other locational variables will be discussed in the section on discontinuous variables.

cent of land over 2000 feet distant from water, (12) per cent of land irrigable, (13) per cent of land in woodland and wasteland, and (14) per cent of farm in level land.[5]

The per cent of each of the five classes of soil on each farm was obtained by measuring the amount of land area in each soil class from a soils map and dividing that number by the total size of the farm. A soil productivity index was obtained by assigning class I soil a value of 1.00, class II soil a value of .80, class III soil a value of .60, class IV soil a value of .40, and class V soil a value of .20. The value of each of the soil classes was multiplied by the per cent of that class of soil on the farm; then summed and designated as an index of soil productivity. The per cent of the farm in improved pastures and unimproved pastures was obtained by having the farmer to classify his pastures as improved or unimproved. Then the enumerator measured the size of the field and divided its acreage by the number of acres in the farm. The percentage of land within specified distances from water was obtained by having the farmer point out all sources of water and indicating the accessibility of the source to his livestock. The distance the livestock traveled was measured by the enumerator. These distances were then used to obtain the percentage of land within a specified distance from water. The per cent of the farm irrigable was obtained by asking the farmer to estimate how many acres he could irrigate. The number of acres was then divided by the size of the farm. The per cent of woodland and wasteland on the farm was obtained by asking the farmer to estimate his

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[5]Sources of water will be discussed in the section on discontinuous variables.

acreage in woodland and wasteland. These acreages were divided by the size of the farm. The per cent of level land in the farm was obtained by asking the farmer to estimate the number of acres in the farm that were level and his estimate was then divided by the farm size.

Other. Variables in the category denoted as other were not necessarily distinguishable or applicable to the other categories. It included: (1) acres in farm, (2) per mil of farm in tobacco allotment, (3) acres of easements, (4) per cent of easements tillable, and (5) per cent of easements pasturable. Acreage in the farm was measured from aerial photographs and other maps. Acres of tobacco allotment were obtained from the County Agricultural Stabilization Committee office. Acreage in easements were estimated by the farmer and checked against TVA records. In cases of close agreement, the TVA record was used. When a large disagreement in the farmer's estimate and TVA records was found, the farmer was asked to reestimate the amount in easements and if not verified, the TVA record was used. The farmer's estimate was used to gain assurance that a proper description had been made of the easement. The per cent of tillable and pasturable easements was obtained by asking the farmer to estimate the number of acres in each use class and dividing it by the size of the easement.

Discontinuous Variables

The discontinuous (dichotomous) variables were those to which responses to specific questions in each of the five categories were non-quantitative. The five categories of responses to specific questions were: (1) improvements, (2) roads, (3) location, (4) natural physical characteristics, and (5) others.

Improvements. These variables were shown as continuous variables in the preceding section. However, they were also used as discontinuous variables in the analysis presented in Chapter V. Yes and no responses were used to indicate the presence of: (1) tenant houses (secondary dwellings), (2) silos, (3) milking houses, (4) tool sheds, (5) chicken houses, (6) hog houses, (7) pump houses, (8) other buildings, and (9) fences.

Roads. The category denoted as roads was defined as the type of avenue of entrance or exit to or from the main dwelling. The types considered were those provided for by public monies which were considered as appurtances to the farm. Roads were classed as: (1) no road, (2) gravel roads, (3) dirt roads, (4) two lane asphalt roads, (5) two lane highways, and (6) four lane highways.

Location. Two variables were included in the location category. The owner of the farm was asked to estimate the distance of the present farm from the place he was reared, and his previous residence. The responses to each of the respective questions were denoted as no when the distance was greater than three miles and yes when the distance was less than three miles. These questions were asked with the intention of determining the influence of clannishness on land values.[6]

Natural physical characteristics of land. The discontinuous variables included in the natural physical characteristics category were the sources of water available on the farm. The specific sources included were presence

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[6]A three mile breaking point was used since there were no observations between three and ten miles. The breaking point could have been defined at ten miles.

of: (1) ponds, (2) springs, (3) wells, (4) creeks, and (5) rivers. When one or more of each source was present, the response was yes and if none were present, the response was no.

Other. The category of other included those discontinuous variables that were not necessarily includable in the other categories. The variables included in this category were further classified into three sub-categories. These were: (1) the intended use, (2) the availability of services, and (3) the ownership of mineral rights. The respondent was asked if he intended to: (1) enlarge his farming operations with the purchase of this farm, (2) live on the new farm, and (3) engage in full-time or part-time farming or use the farm as an investment. Availability of services included the presence of electric power, telephone, mail route, school bus route, and milk pick-up route. The ownership of mineral rights was obtained from the titles.

II. ACQUISITION OF DATA

The source of data for this study was from 63 interviews with all the persons who had purchased farm land with fee simple titles in Jefferson County, Tennessee, during the period July 1, 1955, to June 30, 1957. In other words, the total population was obtained for a given set of qualifications. This study makes no attempt to predict how various variables affect farm land prices in other areas or in different time periods. However, in some circumstances at least, the results found in this study may suggest possible "explainers" and methods to be used in explaining variability in farm land prices in other areas. The area was chosen because: (1) of its similarity to Upper East Tennessee, (2) it avoided some price variability due to differences in the political and socio-economic characteristics among counties, and (3) it lowered the cost of obtaining the data. The following subsections will describe: (1) the area, (2) the qualification of the respondents, and (3) interview procedure.

Description of the Area

Physiographically, the county is situated within the great valley of East Tennessee and covers 312 square miles. The highest elevation in the great valley is about 2,100 feet above sea level at Bristol. The valley slopes gradually southwestward to an elevation of about 600 feet near Chattanooga. The Holston and French Broad Rivers are the two main streams in the county. There are many small perennial streams which provide a supply of water for a rather large proportion of the permanent pastures. Springs are rather common in the limestone valleys, and some of the large ones are actually outflowings of subterranean streams.

The 1950 Census showed a population of approximately 19,667 people. About 16,034 of this total were classed as rural population. The remaining 3,633 was defined as urban population. The Census showed 2,266 farms which averaged 71.3 acres in size; these farms averaged $8,177 in value. Major sources of agricultural income ranked according to the value of the product sold were crops, livestock, dairy, and miscellaneous sales. A total of 21 industries employed 837 people and had a payroll of $1,882,000.[7]

Knoxville and Morristown are the major trade centers outside the county. Dandridge, the county seat, is about 30 miles from Knoxville and 22 miles from Morristown. The major trade centers within the county are

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[7] 1954 Censuses of Population and Agriculture, United States Department of Commerce, Bureau of Census (Washington: Government Printing Office, 1956).

Dandridge and Jefferson City. Major transportation facilities are provided by The Southern Railway and U. S. Highways 11E, 25E, 25W, and 70. Several state highways are also located in the county.

Qualification of Respondents

Researchers engaged in analyzing farm land values have used sales data, owner's opinions, appraisal reports, and census data. Sales data appeared to be the source nearest the realm of farmer experience. Farm transfers have been used to represent sales data. However, farm transfers per se are not generally descriptive of the actual conditions of the sale. Therefore, bona fide fee simple title transfers were used in this study. The study was extended over a two year period in order to obtain enough observations for meaningful analysis. In summary, the qualifications for respondent interview were: (1) the farm was purchased in a bona fide sale, (2) a fee simple title was conveyed from grantor to grantee, and (3) the title was conveyed in the period beginning July 1, 1955, and ending June 30, 1957. These qualifications will be discussed in the following sub-sections and are followed by a discussion of the method in which the data were collected.

Bona fide sale price. A bona fide sale price as used in this study was defined as the consideration agreed upon by the buyer and seller. The bargainors engaged in the act of transferring ownership were acting as individuals and thus not representing an estate, a court, a trustee, or the state. For example, farms sold for payment of taxes, right of eminent domain, foreclosure, or settlement of an estate were excluded from the survey. Instances where the property was transferred as a gift or at reduced prices were established by asking the respondent if either of the situations occurred. When either occurred, the respondent was dropped from the study. Bona fide sales prices were assumed to be those that were representative of the true free market value.

Fee simple title transfers. A fee simple title as used in this study was defined as the total rights in land capable of being conveyed by an individual. Titles which showed encumbrances such as reversioners, entailments, or grantor's liens were excluded. Those containing furnisher's liens, mechanic's liens, tax liens, attachments and mortgages were excluded from the study if they were unknown to the purchaser. Reversioners and entailments were excluded as they would tend to lower the value of the farm. Lack of knowledge of other encumbrances would tend to raise the actual purchase price because the buyer would have to bring suit to become free or would have to pay the amount of the encumbrance.

Sales period. The period July 1, 1955, to June 30, 1957, was used in order to obtain sufficient numbers of observations for the analysis to be presented in the next two chapters. It was assumed that changes in the price level in the local economy were not significant during the period. This assumption appeared reasonable since no new industries were established and no new important roads, dams, bridges, or buildings were constructed.[8]

Interviewing Procedure

Three steps were involved in obtaining the survey data. The first step was a visit to the Jefferson County Court House to select the observations for study (the total population) and determine the approximate sale

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[8]A t test on the average price per acre of the four six months periods showed no significant difference in the mean value per acre.

price. The second step was to visit the list of the respondents selected from the Court House. The third step was to visit other sources of information to acquire data that was not obtainable from the buyer. These three steps will be discussed briefly in the following sections.

Court House. The primary purpose of the visit to the Court House was to secure title transfers that met the qualifications set forth in the previous section; that is, bona fide sales of fee simple titles that were transferred between July 1, 1955, and June 30, 1957.

This step in the collection process consisted of an examination of appropriate record books.[9] Warranty Deed Books are arranged according to the time the deed was recorded. An examination of deeds recorded between the dates of July 1, 1955, and June 30, 1957, provided a list of all transfers between those dates.[10] This examination also provided information that led to the elimination of some of the transfers where less than a fee simple title was conveyed. The Reverse Index, and other appropriate references, established the reverse chain of title for the minimum time requirements of this study.[11] After chains of titles were established, an examination of the Direct Index and other appropriate references showed the amount of title interest conveyed in the last transfer. Specific attention was given to transfer of mineral rights, fee simple reversioners, fee tail, right of ways, recorded leases, retained life estates, mortgages (Trust Deeds), and

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[9]See Appendix A for copy of the form used in the Court House.

[10]Worley v. State, 75 Tennessee 382 (1881), 78 ALR 116.

[11]The title was searched backward for four previous transfers or 25 years, whichever was greater.

liens.[12] All titles containing reversioners, retained life estates, and/or entailments were eliminated from the study in compliance with the specifications set forth in the previous sub-section. A description of the tract was obtained from the register's office in addition to an approximate sale price (stated in the deed and/or inferred by revenue stamps), location of the tract, and information used to partially determine if the sale was bona fide.

The records of the courts having jurisdiction in Jefferson County were examined to ascertain if the tract in question was in court. If it was attached, then it was excluded from the study because the owner could not pass full title.[13] The Federal Tax Lien Book was examined to ascertain if the grantor (seller) or his predecessors in title had a lien filed against them (hence against their property).[14]

Farmer. The visit to the farmer was made to ascertain if he qualified for the interview. If he qualified, he was asked what he paid for the farm and other appropriate questions pertaining to variables specified earlier in this chapter, e.g., value of improvements, distances, sources of water, and purposes of purchase.[15]

Since the respondent qualifications required special treatment and are not necessarily shown on the interview form, this step of the collection of data will be discussed briefly. The purchase price given by the respondent was checked against the value (if any) shown by the deed. Questions

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[12]Worley v. State, 75 Tennessee 382 (1881), 28 TCA 212.

[13]Venditioni exponas, 23 TCA 657, 658, 665.

[14]26 USCA 3670, 3678, 3679.

[15]See Appendix B for farmer interview form.

(implied by but not stated in the schedule) were asked about any encumbrances in the title and appropriate corrections were made if justified or if not justified the interview was terminated and the transfer was excluded from the study on the basis of qualifications. As an example, the enumerator asked the question, "Is there a mortgage on this farm?" If the respondent's answer was "yes" and the record showed that there was a mortgage, then an adjustment was made in the purchase price to show the assumption of the debt if not already included in the purchase price. If the respondent answered "no" and the record showed an outstanding mortgage, the enumerator continued to probe for an answer that would indicate that the respondent had knowledge of an outstanding mortgage. When the enumerator decided that the respondent knew nothing about the mortgage then the interview was terminated. Great care was used to prevent the respondent from acquiring information about the title from the enumerator. The questions on the title were not specific or asked at any specific time, and the interview was not terminated abruptly or at any specific time. The questions were asked in this manner to avoid implementing conflicts between the present owner and his predecessor in title. Furthermore, great care was exercised to keep the respondent from gaining the impression that the enumerator was a lawyer or attempting to practice law.

Another question requiring special treatment was that of determining if the purchase and sale was bona fide. There were several questions in the schedule for the purpose of determining if the transfer was bona fide. Any transfers found to be mala fide were excluded from the study.

Other sources. The seller of each tract of land in question was visited to determine the approximate farm size and the sale price. This information was used to verify the data obtained from the buyer and the title. In most instances these sources agreed.

The Tennessee Valley Authority provided maps of some of the farms, information on improvements, distances to various points, and amount of easements. These were checked against the farmers' estimates. Some farmers were not aware of the size of the easements for a given power line. The Jefferson County ASC office provided additional maps and aerial photographs.

III. SUMMARY

This chapter has presented a discussion of possible variables to be used in explaining variability in land prices and the source and methods of obtaining survey data for this thesis. Continuous and discontinuous variables believed to explain land price variability were defined for five categories. These categories included improvements, roads, location, natural physical characteristics of the land, and others. The respondent qualifications were: (1) the farm was purchased in a bona fide sale, (2) a fee simple title was obtained for the farm, and (3) the title to the farm was transferred between July 1, 1955, and June 30, 1957.

From this point on, this thesis will be devoted to analyzing these data. Chapter IV will be used to discuss the results from analyzing the data by least squares regression techniques. Chapter V is used to demonstrate the results of an analysis of the discontinuous variables by using biserial correlations.

CHAPTER IV

ANALYSIS OF CONTINUOUS VARIABLES

It is not difficult to observe a large amount of variation in the sale prices of farm land. The sale price and the appraisal report from various agencies are seldom in agreement. This wide variation in land prices calls for an "explanation." The intent of the remainder of this thesis is to select important variables that are associated with variation in farm land prices. Least squares regression will be used in this chapter to select continuous variables associated with the variations in farm land prices.

The objective at this stage was to obtain parameters for specific equations that would "explain" variation in these land prices. The equation in general form is:

$$Y = f(X_1 \ldots X_n a_1 \ldots a_n U) \quad \text{where,}$$

Y is the land price, X_j are the independent variables, a_j are the parameters obtained by least squares, and U is the residual. The residual or error term (U) results from errors in the equation. This error arises from the improper selection of the algebraic form of the equation and excluding important independent variables. Two statistical criteria which made use of the error term either directly or indirectly were used to select relevant variables. These were: (1) the independent variable had to be correlated with the dependent variable, and/or (2) the excluded independent variables had to be correlated with the calculated residuals. In most cases the inclusion of the excluded variable satisfying either criteria would result in a "better fit" when the new independent variable was not highly correlated with the independent variables already included in the equation.[1] The first section of this chapter is used to demonstrate the simple correlations of each of the independent variables with the dependent variable (land price). A discussion of the results of using several independent variables will be shown in the second section.

I. SIMPLE REGRESSION

The data were plotted using the price per acre as the dependent variable against each of several independent variables. The plot served to indicate the algebraic form of the equation and to show the relative variability in the independent and dependent variables.[2] The following independent variables were used:

X_1 dollar value of main dwelling per acre,

X_2 total dollar value of improvements per acre less the value of the main dwelling per acre,

X_3 soil productivity expressed as an index,

X_4 miles to a two lane highway,

X_5 miles to a four lane highway,

X_6 total acres in the farm,

X_7 per cent of farm in improved pasture,

X_8 per cent of land used for livestock less than 2000 feet from water,

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[1]In cases where the excluded variable was correlated with the calculated residuals its inclusion in the equation would at least remove some bias in the regression coefficients.

[2]Selected scattergrams are shown in Appendix C.

X_9 per cent of farm irrigable,

X_{10} per cent of farm in tobacco allotment multiplied by 10,

X_{11} feet of road frontage,

X_{12} per cent of class I soil,

X_{13} per cent of class II soil,

X_{14} per cent of class III soil,

X_{15} per cent of class IV soil,

X_{16} per cent of class V soil,

X_{17} total dollar value of main dwelling,

X_{18} total dollar value of the main barn,

X_{19} total dollar value of other barns,

X_{20} total dollar value of improvements,

X_{21} total value of improvements per acre,

X_{22} per cent of farm in woodland or wasteland,

X_{23} per cent of farm in unimproved pasture,

X_{24} per cent of farm in level land,

X_{25} acres under easement,

X_{26} per cent of easement tillable,

X_{27} per cent of easement pasturable,

X_{28} per cent of land used for livestock between 500 and 2000 feet from water, and

X_{29} per cent of land used for livestock more than 2000 feet from water.

A simple linear equation, $Y = a + bX + U$, was fitted to the data using each of twenty-nine independent variables and price per acre. The results are shown in Table III.[3] An examination of the scattergrams along with a low degree of linear correlation showed that the linear equation was not necessarily descriptive of the data in some cases. Thus three curvelinear equations were used to describe the simple relationship between the dependent and some of the independent variables. The three equations selected were:

(1) $\text{Log } Y = \log a + b \log X + \log U$,

(2) $\text{Log } Y = \log a + b \log X + c \log X^2 + \log U$, and

(3) $Y = a + bX + cX^2 + U$.

Table IV indicates how a "better fit" may be obtained by the use of different equations. The following variables were "fitted" with a simple curvelinear equation:

X_{10} per mil of farm in tobacco allotment

X_{11} amount of road frontage

X_{17} value of main dwelling

X_{18} value of main barn

X_{19} value of other barns

X_{20} value of total improvements

X_{21} value of total improvements per acre

X_{24} per cent of farm in level land

X_{28} per cent of land between 500 and 2000 feet of water

X_{29} per cent of land over 2000 feet from water

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[3]Several of the simple correlation coefficients were small. However, the data used comprised the total population; thus all correlation coefficients were the true population coefficients.

TABLE III

SIMPLE LINEAR CORRELATIONS AND REGRESSION COEFFICIENTS USING PRICE PER ACRE AS THE DEPENDENT VARIABLE WITH EACH OF SEVERAL INDEPENDENT VARIABLES
(N = 63)

Variable	Linear Equation[a] a	b	r
X_1 (Value of dwelling per acre)	145.0348	+ .1601	+ .1175
X_2 (Value of other improvements per acre)	141.9497	+ .3402	+ .1763
X_3 (Soil index)	141.1191	+ .1987	- .0414
X_4 (Distance to two lane highway)	160.4550	- .6285	- .1053
X_5 (Distance to four lane highway)	169.3683	-1.6194	- .1381
X_6 (Acres)	161.6566	- .0987	+ .1050
X_7 (Per cent of improved pasture)	27.4101	+3.2683	+ .5682
X_8 (Per cent of farm less than 2000 feet of water)	59.4221	+1.3790	+ .5195
X_9 (Per cent of farm irrigable)	144.0545	+ .2089	+ .0915
X_{10} (Per mil of farm in tobacco allotment)	143.7172	+1.1403	+ .0847
X_{11} (Amount of road frontage)	138.8818	+ .7684	+ .2022
X_{12} (Per cent of class I soil)	160.0109	- .6476	- .1740
X_{13} (Per cent of class II soil)	136.2438	+ .9307	+ .2196
X_{14} (Per cent of class III soil)	151.7238	+ .0362	+ .0067
X_{15} (Per cent of class IV soil)	143.5791	+ .7370	+ .0992
X_{16} (Per cent of class I soil)	162.4641	-2.5319	- .1627
X_{17} (Value of main dwelling)	125.9267	+ .9148	+ .3161
X_{18} (Value of main barn)	128.7699	+1.3750	+ .3490
X_{19} (Value of other barns)	133.5566	+2.7522	+ .3490
X_{20} (Value of total improvements)	116.9497	+ .0958	+ .4543

TABLE III (continued)

Variable	Linear Equation[a] a	b	r
X_{21} (Value of total improvements per acre)	128.5928	+ .4904	+ .2552
X_{22} (Per cent of farm in woodland and wasteland)	125.0350	-1.3629	- .4910
X_{23} (Per cent of farm in unimproved pasture)	154.3754	- .5130	+ .2349
X_{24} (Per cent of farm in level land)	169.5400	- .7185	- .2554
X_{25} (Acres of easements)	151.8572	+ .0439	+ .0065
X_{26} (Per cent of easement tillable)	154.1520	- .2478	- .0730
X_{27} (Per cent of easement pasturable)	156.4314	- .2300	- .0981
X_{28} (Per cent of land between 500 and 2000 feet of water)	143.2946	+ .2534	+ .0829
X_{29} (Per cent of land over 2000 feet of water)	196.0799	-1.3602	- .5174

[a] $Y = a + bX$

TABLE IV

COMPARISON OF SIMPLE CORRELATION COEFFICIENTS FOR SPECIFIC VARIABLES AND EQUATIONS

Variable	Linear Equation[a]	Log Equation I[b]	Log Equation II[c]	Parabola[d]
X_{10} (Per mil of farm in tobacco allotment)	+ .0847	---	+ .2376	+ .2404
X_{11} (Amount of road frontage)	+ .2022	+ .3178	+ .3178	+ .4671
X_{17} (Value of dwelling I)	+ .3161	+ .7012	---	+ .3162
X_{18} (Value of barn I)	+ .3490	+ .5858	---	+ .4315
X_{19} (Value of barn II)	+ .3490	+ .5314	---	---
X_{20} (Value of total improvements)	+ .4543	---	+ .6730	+ .6930
X_{21} (Value of total improvements per acre)	+ .2552	---	+ .4389	---
X_{24} (Per cent of farm in level land)	- .2554	---	+ .0947	+ .4137
X_{28} (Per cent of land between 500 and 2000 feet of water)	+ .0829	+ .7068	---	---
X_{29} (Per cent of land over 2000 feet of water)	- .5174	- .6741	---	---

[a] $Y = a + bX + U$.

[b] $\log Y = \log a + b \log X + \log U$.

[c] $\log Y = \log a + b \log X + c \log X^2 + \log U$.

[d] $Y = a + bX + cX^2 + U$.

The use of a curvelinear equation in many cases increases the value of the correlation coefficient because of its "fit" to the actual data. For example, the linear correlation coefficient between price per acre and value of the main dwelling was .3161 as compared to the logarithmic curvelinear correlation coefficient of .7012. The linear correlation coefficient using value of total improvements as the independent variable was .4543 compared to the *r* of a parabolic equation of .6930. The per cent of farm in level land had a simple linear correlation coefficient of - .2554, but when a parabolic equation was used to express the relationship, the correlation coefficient was + .4137. Table IV indicates that errors result from the specification of the form of the equation.

The multiple regressions, which will be discussed in the next section, were for a linear relationship; therefore, specification error from selection of the algebraic form may result in larger residuals.

II. MULTIPLE REGRESSION

The results of simple correlation did not explain much of the variability of prices of farm lands. It was the intent of this study to explain more of the variability in land price than was explained by these simple regressions. Thus, multiple regression was used in an attempt to explain more of the variability by combining independent variables that were not highly intercorrelated.

The form of the multiple regression equation used in this study was linear. It was noted that many of the variables had a "better fit," i.e., larger r's, when a curvelinear equation was used to describe the simple relationship. The use of a multiple curvelinear equation might have provided a "better fit" in the multiple analysis. However, a multiple curvelinear equation was not used because of the difficulty of "fitting" by hand. Had an electronic computer been available, many other combinations of variables and algebraic equations could have been tested.

The first equation contained those variables that appeared to be the most important variables used by farmers when they were estimating the value of a prospective farm for purchase. These same variables have been cited as important influences in other studies.[4]

A linear equation was fitted to the data of the form:

$Y = a + b_1X_1 \; . \; . \; . + b_{11}X_{11} + U$ where,

Y denoted price per acre,

X_1 denoted dollar value of main dwelling per acre,

X_2 denoted dollar value of other improvements per acre,

X_3 denoted soil index,

X_4 denoted distance to two lane highway,

X_5 denoted distance to four lane highway,

X_6 denoted size of farm in acres,

X_7 denoted per cent of improved pasture,

X_8 denoted per cent of land less than 2000 feet from water,

X_9 denoted per cent of land irrigable,

X_{10} denoted per mil of land in tobacco allotment,

X_{11} denoted number (amount) of road frontage, and

U denoted unexplained error.

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[4]See footnotes in Chapters 6, 7, 12, 16, and 18 William G. Murray, Farm Appraisal (The Iowa State College Press, 1954), and Frank H. Maier, James L. Hedrick, and W. L. Gibson, Jr., The Sale Value of Flue-Cured Tobacco Allotments (Virginia Polytechnic Institute Agricultural Experiment Station), Bulletin No. 148, April, 1960.

The coefficient of multiple determination was .46187. The regression coefficient shown in Table V represents the true population coefficient for this particular equation and set of variables. The standard error of the regression coefficients (S_b) were very large indicating a large amount of variability of this population of regression coefficients. The partial regression coefficient indicated that each variable contributed a small degree toward explaining variability in the independent variable, price per acre. These results were not too surprising since some of the independent variables had fairly high intercorrelations and only two of the simple correlation coefficients were greater than .50.[5]

Two criteria were set forth at the beginning of the chapter to select important independent variables. The first, correlation of the dependent and independent variables, was not satisfied by the first regression. Thus the calculated residuals from the first regression were plotted against the other eighteen (18) independent variables in the intention of satisfying the second criteria, i.e., correlation of independent variables with the residuals. These plots did not offer encouraging results for expanding the eleven (11) variable equation since none of the additional variables appeared to be correlated with the calculated residuals. Therefore the first regression was not expanded by including more of the continuous independent variables. The discontinuous variables were analyzed by biserial correlation as possible explainers of the residuals as will be discussed in Chapter V.

A second equation was "fitted" to the data using only five independent variables since the criteria set forth at the beginning of the chapter did

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[5]See Table in Appendix D.

TABLE V

REGRESSION COEFFICIENTS, STANDARD ERRORS OF REGRESSION COEFFICIENTS, PARTIAL CORRELATION COEFFICIENTS, AND MEANS FOR FIRST LINEAR REGRESSION
(R^2 = .46187)

		b_n	S_b	r	$\bar{X}$
X_1	(Value of dwelling per acre)	.3079	.5317	.0065	44.0159
X_2	(Value of other improvements per acre)	-1.0127	.6838	.0412	29.7778
X_3	(Soil index)	- .0092	1.3938	.0001	55.1587
X_4	(Distance to two lane highway)	.0787	.1197	.0084	13.3016
X_5	(Distance to four lane highway)	1.2199	.3932	.1588	10.6667
X_6	(Acres)	.3355	.3215	.0209	96.8889
X_7	(Per cent of farm in improved pasture)	.1513	1.5540	.0002	27.7619
X_8	(Per cent of land less than 2000 feet of water)	.3449	.4449	.0116	67.1905
X_9	(Per cent of land irrigable)	.0966	.1830	.0054	3.8413
X_{10}	(Per mil of farm in tobacco allotment)	.4357	.2540	.0546	7.3333
X_{11}	(Amount of road frontage)	1.0921	.3623	.1513	17.1746
		a = 142.25			
Y	(Price per acre)				152.09

not appear to give useful results in the first regression.[6]

The second regression was obtained by fitting the same form of linear equation to five variables in the improvement category. Variables included in this regression were:

Y denoted price per acre,

X_{17} denoted value of main dwelling,

X_{18} denoted value of main barn,

X_{19} denoted value of other barns,

X_{20} denoted value of total improvements,

X_{21} denoted value of total improvements per acre, and

U denoted the unexplained residual.

The results from the second regression are shown in Table VI. The coefficient of multiple determination was only .2492 which indicated that less than twenty-five per cent of the variation in the dependent variable was explained by the regression. The simple correlation coefficients between the dependent variable and each of the independent variables was greater than .25 but less than .45. The intercorrelation between the independent variables were exceedingly high.[7] This demonstrates the difficulty of obtaining a good "fit" and interpreting the regression coefficients when a high degree of intercorrelation is present among the independent variables. Furthermore, four of the variables showed a curvelinear equation gave a

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[6] A limited amount of computer time became available and four regressions were obtained using five independent variables each. The capacity of the machine would only allow five independent variables to be used. The second, third, fourth, and fifth equations were "fitted" to the data using an electronic computer.

[7] See Table in Appendix D.

TABLE VI

REGRESSION COEFFICIENTS, STANDARD ERRORS OF REGRESSION COEFFICIENTS, AND MEANS FOR SECOND LINEAR REGRESSION

(R^2 = .24921)

	b_n	S_b	$\bar{X}$
X_{17} (Value of main dwelling)	- .6666	.6428	28.5873
X_{18} (Value of main barn)	1.3356	.7921	16.9524
X_{19} (Value of other barns)	- .1582	1.4908	6.7302
X_{20} (Value of total improvements)	.1084	.0416	366.7937
X_{21} (Value of total improvements per acre)	.1724	.2919	47.8889
	a = 99.03		
Y (Price per acre)			152.09

"better fit" in the simple regression as was discussed in the previous section.[8]

The *third* regression was obtained by "fitting" a linear equation to the dependent variable (price per acre) and five variables in the natural physical characteristics of land category. These independent variables included:

Y denoted price per acre,

X_6 denoted acres in farm,

X_7 denoted per cent of improved pasture,

X_{22} denoted per cent of woodland and wasteland,

X_{23} denoted per cent of unimproved pasture,

X_{24} denoted per cent of level land on farm, and

U denoted unexplained error.

Results of this regression are shown in Table VII. The coefficient of multiple determination was .4506 which was about as good as the ones obtained in the *first* regression and much better than the *second* regression. Two of the simple correlation coefficients were about .5 while the other three were less than .25. The intercorrelations among the independent variables were small in comparison with the previous regressions.[9]

The *fourth* regression was obtained by "fitting" a linear equation to the dependent variable (price per acre) and five independent variables. These variables were:

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[8]See Table IV, page 33.

[9]See Table in Appendix D.

TABLE VII

REGRESSION COEFFICIENTS, STANDARD ERRORS OF REGRESSION COEFFICIENTS, AND MEANS FOR THIRD LINEAR REGRESSION

(R^2 = .45059)

	b_n	S_b	$\bar{X}$
X_6 (Acres)	.0121	.0958	96.8889
X_7 (Per cent of improved pasture)	1.3399	.3341	27.7619
X_{22} (Per cent of woodland and wasteland)	- .9556	.3102	32.4444
X_{23} (Per cent of unimproved pasture)	.2614	.2693	37.0952
X_{24} (Per cent of level land)	- .2488	.2975	24.3016
	a = 141.077		
Y (Price per acre)			152.09

Y denoted price per acre,

X_{10} denoted per mil of farm in tobacco allotment,

X_{25} denoted acres of farm with an easement,

X_{26} denoted per cent of easement tillable,

X_{27} denoted per cent of easement pasturable,

X_{28} denoted per cent of farm between 500 and 2000 feet of water, and

U denoted the unexplained error.

Results of regression __four__ are shown in Table VIII. The coefficient of multiple determination was .0552 which was greater than any of the simple coefficients of determination of the independent variables. The simple linear correlation coefficients (r's) ranged from .006 to .098 (r^2 .000036 to .0096).[10] There were evidences of some high intercorrelation among the independent variables. Furthermore, one independent variable was curvelinearly related to the price per acre.[11]

The __fifth__ regression was obtained by "fitting" a linear equation to the dependent variable and other independent variables. These variables were:

Y denoted price per acre,

X_4 denoted distance to a two lane highway in tenths of miles,

X_5 denoted distance to a four lane highway in miles,

X_9 denoted per cent of farm irrigable,

X_{11} denoted feet of road frontage,

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[10]See Table in Appendix D.

[11]See Table IV, page 33.

TABLE VIII

REGRESSION COEFFICIENTS, STANDARD ERRORS OF REGRESSION COEFFICIENTS, AND MEANS FOR FOURTH LINEAR REGRESSION

(R^2 = .05523)

	b_n	S_b	$\bar{X}$
X_{10} (Tobacco allotment)	.3664	1.8622	7.3333
X_{25} (Acres in easement)	2.7806	2.0367	5.4286
X_{26} (Per cent of easement tillable)	.6407	.7534	8.3016
X_{27} (Per cent of easement pasturable)	-1.3354	.8871	18.8571
X_{28} (Per cent of land between 500 and 2000 ft. of water)	.3005	.4012	34.6667
	a = 143.760		
Y (Price per acre)			152.09

X_{29} denoted per cent of land over 2000 feet of water, and

U denoted the unexplained variable.

The results of the fifth regression are shown in Table IX. The coefficient of multiple determination was .3234 which was greater than any of the individual simple linear coefficients of determination. The intercorrelation among the independent variables was low.[12] Two of the independent variables, X_4 and X_{11}, had a better fit when a curvelinear equation was applied as shown in the first section of this chapter; therefore the multiple coefficient of determination (R^2) tended to be lower when a linear equation was applied.

The sixth regression was obtained by fitting a linear equation to the dependent variable and four independent variables. The independent variables were selected for this equation by choosing the variables associated with the largest beta coefficients from the previous equations. These variables were:

Y denoted price per acre,

X_7 denoted per cent of improved pasture,

X_{20} denoted value of total improvements,

X_{22} denoted per cent of woodland and wasteland,

X_{29} denoted per cent of farm over 2000 feet from water, and

U denoted the unexplained error.

The results of the regression are shown in Table X. The coefficient of multiple determination was .52698 which was greater than any of the individual simple linear coefficients of determination. The simple linear

[12] See Table in Appendix D.

TABLE IX

REGRESSION COEFFICIENTS, STANDARD ERRORS OF REGRESSION COEFFICIENTS, AND MEANS FOR FIFTH LINEAR REGRESSION

(R^2 = .32341)

		b_n	S_b	$\bar{X}$
X_4	(Distance to two lane highway)	-1.3693	.7058	13.3016
X_5	(Distance to four lane highway)	- .0001	1.3682	10.6667
X_9	(Per cent of land irrigable	-1.0483	2.8008	3.8413
X_{11}	(Amount of road frontage)	.3726	.4571	17.1746
X_{29}	(Land over 2000 ft. from water)	-1.4413	.3221	32.3492
		a = 214.562		
Y	(Price per acre)			152.09

TABLE X

REGRESSION COEFFICIENTS, STANDARD ERRORS OF REGRESSION COEFFICIENTS, PARTIAL CORRELATION COEFFICIENTS, AND MEANS FOR SIXTH LINEAR REGRESSION

(R^2 = .52698)

	b_n	S_b	r	$\bar{X}$
X_7 (Percent improved pasture)	-1.2017	.3782	.1483	27.7619
X_{20} (Value of total improvements)	.0231	.0249	.0147	366.7937
X_{22} (Per cent of woodland and wasteland)	- .5961	.3078	.0607	32.4444
X_{29} (Per cent of land over 2000 ft. from water)	- .9690	.2668	.1853	32.3492
	a = 225.28			
Y (Price per acre)				152.09

correlation coefficient (r's) ranged from .45 to .57. The intercorrelation was small.[13] One of the variables, X_{20}, indicated that a curvelinear equation would give a better "fit" and would have increased the size of the multiple regression coefficient (R^2). The variables in this equation were very similar to those in the first regression,[14] i.e., it contained variables associated with improvements, land use, and availability of water.

The seventh regression was obtained by fitting a linear equation to the dependent variable and five independent variables. The independent variables were selected on the basis of the "R^2 build up" associated with that variable from the computer analysis on the data. The variables were:

Y denoted price per acre,

X_5 denoted miles distance to a four lane highway,

X_7 denoted per cent of improved pasture,

X_{11} denoted feet of road frontage

X_{22} denoted per cent of woodland and wasteland,

X_{29} denoted per cent of farm over 2000 feet from water, and

U denoted unexplained error.

The coefficient of multiple determination was .7262 and was significantly greater than any of the simple linear correlation coefficients (r's) which varied from .138 to .568. The intercorrelations among the independent variables were small.[15] It was pointed out in previous sections that the inclusion of variables which were curvelinearly related tended to reduce

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[13]See Table in Appendix D.

[14]See Table in Appendix D.

[15]See Table in Appendix D.

the size of the R^2. In this equation only one of the independent variables showed a curvelinear relationship. Table IV shows that the simple linear correlation coefficient was .202 and the simple second degree polynomial correlation coefficient was .467; therefore, the multiple coefficient of determination would be larger if a curvelinear equation had been used for this particular variable.

The regression coefficient b and the simple correlation coefficient were negative for the variable X_5 (distance to four lane highway). This was expected because as the distance that a person must travel increases, the value of the farm showed a decrease as it follows the Von Thunen's theory[16] and the theory of marginal costs (cost of transportation) and returns.

The simple correlation and the multiple regression coefficients were positive and linear for the variable X_7 (per cent of improved pasture). For each increase of 5 per cent in the amount of the farm that is in improved pastures with other variables held constant there was a corresponding increase in the value or sale price of the farm of $7.42 per acre. It may be assumed that the reason for this is the cost of improving pastures is capitalized into the value of the farmer. However fact may be the cause of this positive relationship, in that the prospective (actual) purchaser is willing to pay for the added beauty of improved pastures over unimproved pastures assuming that improved pastures are more attractive than unimproved ones.

The amount of road frontage (X_{11}) had a negative regression coefficient (b_{11}). The negative slope may be rationalized in that the farmer may build additional fences along a road which causes excessive amounts of road

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[16]Raleigh Barlowe, Land Resource Economics (Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1958), p. 33.

fence that require additional maintenance. Roads tend to increase the surface water run off which may create a drainage problem to the farmer and the dividing of a farm by a road may cause inefficiencies in the farm operation.

The regression coefficient for X_{22} indicated that for each increase of 10 per cent in the amount of woodland and wasteland of the farm there was a corresponding decrease in the value per acre of $2.65. This was expected because much of the land that is in this group is not suitable for farming. The woodland in Jefferson County is generally cut over and not suitable for being used as lumber. Also any land that was sold for commercial sawmilling purposes was excluded from this study.

The regression coefficient for X_{29} indicated that for each 10 per cent increase in the amount of land over 2000 feet from adequate water for livestock there is a corresponding decrease of $7.95 per acre for the farm. This can be explained by the fact that livestock must have water and the availability of it has a great influence profitability of livestock enterprises. The farmer may take this into consideration in setting the price he was willing to pay for the tract of land.

III. SUMMARY

This chapter has shown the variability of the dependent variable (price per acre) around the regression mean by the use of selected scattergrams. In Table IV it was shown that the use of a curvelinear equation would, in some instances, provide a "better fit" to the data. In Table V it was shown that the eleven independent variables that were selected on the basis of previous studies would only explain 46 per cent of the variability of the price per acre. Table VI showed the effect of high intercorrelation on the interpretation of the multiple determination coefficient (R^2). Table VII indicated that the land use pattern or natural characteristics of the land were as good an indicator of sale price as the variables selected from other studies. Table X indicated that the use of improved and natural physical characteristics provided a better indicator than either separately. Table XI showed that the five variables used explained 73 per cent of the variability of the price per acre. Table XI showed that the five independent variables explained 73 per cent of the variability of the dependent variable, price per acre. The error may result from the wrong algebraic equation or excluded variables. The excluded variables causing the error may be the discontinuous variables which will be discussed in Chapter V.

TABLE XI

REGRESSION COEFFICIENTS, STANDARD ERRORS OF REGRESSION COEFFICIENTS, PARTIAL CORRELATION COEFFICIENTS, AND MEANS FOR SEVENTH LINEAR REGRESSION

(R^2 = .7262)

	b_n	S_b	r	$\bar{X}$
X_5 (Distance to four lane highway)	- .8101	.7459	.1462	10.6667
X_7 (Per cent of improved pasture)	1.4837	.2094	.6941	27.7619
X_{11} (Amount of road frontage)	- .3172	.2466	.1724	17.1746
X_{22} (Per cent of woodland and wasteland)	- .2651	.2009	.1767	32.4444
X_{29} (Per cent of land over 2000 ft. of water)	- .7947	.1913	.4921	32.3492
	a = 147.91			
Y (Price per acre)				152.09

CHAPTER V

ANALYSIS OF DISCONTINUOUS VARIABLES

The "best fit" obtained in the previous chapter was the use of a linear equation fitted to price per acre, miles to four lane highway, per cent of improved pasture, footage of road front, per cent of woodland and wasteland, and per cent of land over 2,000 feet from stock water. These were discussed from the standpoint of "reasonableness" of the relationship and statistical consideration, i.e., "goodness of fit." These variables left more than 27 per cent of variation in the dependent price per acre "unexplained." The intent of this chapter is to present ways in which discontinuous variables might be used to explain some of the variation in land prices. Biserial correlation will be used to point out ways of detecting discontinuous variables that might be expected to improve the results in a multiple regression analysis. The first section will demonstrate the use of biserial correlation. The second section will postulate ways in which these types of variables can be used in regression.

I. BISERIAL CORRELATION

Since biserial correlation is a unique tool of statistical analysis for research in land values, a brief discussion will be presented and will be followed by a practical application. In a non-book length definition, biserial correlation measures the degree of linear relationship between a dichotomous variable and a continuous variable.

Discussion of Biserial Correlation

There are numerous situations in which one of the two variables can be observed in two categories. The Chi Square (χ^2) test can provide a measure of this relationship, but it is limited in its use like the use of cross-classification because both variables must be made discontinuous. Thus, χ^2 expressed independence between discontinuous variables. The coefficient of Phi correlation ($r\phi$) is very similar of the Chi Square (χ^2) test except it provides a measurement of a relationship.

The Phi correlation can be used to derive the product-moment biserial correlation which will provide a measure of independence of a continuous variable and/or discontinuous variable. The simple formula for the product-moment correlation coefficient in the biserial situation is:

$$r_{pb_i} = \frac{(\bar{Y}_1 - \bar{Y}_2)\sqrt{PQ}}{S_y} \quad \text{where,}$$

$\bar{Y}_1$ denotes the mean of the dependent variable for a given response to the independent variable,

$\bar{Y}_2$ denotes the mean of the dependent variable to other response to the independent variable,

P denotes proportion of the responses of $\bar{Y}_1$,

Q denotes proportion of the responses of $\bar{Y}_2$,

S_y denotes the standard deviation of the dependent variable.

The product-moment condition will be referred to as point biserial correlation It makes no assumption that the population of the dichotomy is normally distributed. Therefore, it was used in those cases where a continuous variable was impractical to define. When the population is normally distributed, on the assumption that the variable underlying the dichotomy is continuous, the properties of the normal curve may be utilized to derive the following equation:

$$r_{bi} = \frac{\bar{Y}_1 - \bar{Y}_2}{S_y} \cdot \frac{PQ}{Y'} \text{*} \quad \text{where,}$$

Y' is the ordinate under the normal curve. The assumptions necessary for meaningful interpretation of r_{bi} are: (1) the dependent variable (Y) is normally distributed, (2) the true distribution underlying the dichotomized variable (X) is normal, and (3) the regression of Y on X is linear. This condition is henceforth referred to as biserial correlation.

Application of Biserial

Two statistical criteria have been set forth in this thesis for selecting relevant variables as "explainers" of farm land price variability. These criteria were that relevant variables must be: (1) correlated with the price per acre, and/or (2) correlated with the calculated residuals from the multiple regression equation. An additional criterion, that of "reasonableness," was also specified. Two biserial correlation coefficients were computed for each of the dichotomous variables used as an independent variable and either price per acre or the calculated regression residuals as the dependent variable. The calculated regression residuals were those obtained from the *first* regression discussed in Chapter IV.[1]

Point biserial correlation analysis. The variables that were analyzed by point biserial correlation were those that were impractical to measure as

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*George A. Ferguson, *Statistical Analysis in Psychology and Education* (New York: McGraw-Hill Book Company, Inc., 1959), pp. 203-204.

[1]Time did not permit using the residuals from the regression that gave the best fit, i.e., number *seven*.

continuous variables.[2] Table XII shows the variables and the point biserial coefficients using the price per acre and the calculated regression residuals from the <u>first</u> regression as dependent variables. Independent variables analyzed in this manner included:

X_{30} reason for purchase was to increase size of farm

X_{31} intention of buyer to live on farm

X_{32} availability of electric power

X_{33} availability of telephone service

X_{34} availability of mail route

X_{35} availability of school bus route

X_{36} availability of milk pickup route

The highest point biserial correlations using price per acre as the dependent variable ranged from .2215 to .3054. Individual variables included in these correlations were availability of telephone service, mail route, school bus, and milk pickup route. Nearly all these variables also had the highest coefficient with the calculated residuals. The variables which showed the highest degree of correlation also showed the greatest differences in the means of the dependent variable for each of the responses (Table XII). Furthermore, greater differences were shown in frequencies of similar responses or proportions. For example, the difference in the mean value of the price per acre for those who had telephone service available for 54 of the 63 respondents. The point biserial correlation (using

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[2]The equation used was:

$$r_{pb_i} = \frac{\bar{Y}_1 - \bar{Y}_2}{S_y} \cdot PQ$$

TABLE XII

THE MEAN, STANDARD DEVIATION OF MEAN, CALCULATED t, CORRELATION COEFFICIENTS OF INDEPENDENT VARIABLES WITH PRICE PER ACRE AND RESIDUAL, AND RESIDUAL FOR POINT BISERIALY CORRELATED VARIABLES

Variable	N	Mean	Std. dev. of mean	Calculated t	Dependent variable r	Residual r	$\bar{U}$
X_{30} Reason for purchase							
To increase size of farm	24	158.04	63.46	.410	.0388	.0503	− 6.412
Other reasons	39	150.74	70.58				3.113
X_{31} Intend to live on tract							
Yes	42	138.65	62.81	1.144	.0980	.1888	−12.271
No	21	157.79	61.27				24.614
Services available							
X_{32} Electricity available							
Yes	61	152.83	68.82	1.809	.0432	.1727	89.532
No	2	129.57	13.29				− 3.468
X_{33} Telephone available							
Yes	48	166.63	71.89	3.737	.2839	.2251	11.552
No	15	105.56	48.88				−36.865
X_{34} Mail route available							
Yes	54	161.26	70.47	2.931	.2451	.0723	2.901
No	9	98.20	57.49				−15.223
X_{35} School bus route available							
Yes	51	164.55	69.33	3.626	.2775	.2696	12.048
No	12	99.57	52.19				−51.075
X_{36} Milk pickup route available							
Yes	50	167.01	69.10	3.482	.2928	.1838	8.576
No	13	100.98	58.39				−32.866

price per acre) was .0388 when the reason for purchase was either to increase the size of the farm or not to increase the size of the farm. The difference in this mean price per acre was 7.30, and 24 out of 63 respondents intended to increase the size of the "older" farm. Hence, the correlation coefficient would be expected to be small since differences in the means and proportions were small.

It should be apparent that the difference in the mean for the responses for a given variable and the difference in the proportions materially affect the size of the biserial correlation coefficient. There are four ways in which the differences can occur for a given response: (1) large difference in the mean and a small difference in the proportion, (2) small difference in the mean and a large difference in the proportion, (3) large difference in the mean and the proportion, and (4) small difference in the mean and the proportion. Biserial correlation provides a method of weighing the importance of these differences so that a composite expression can be given to the degree of the relationship.

Those variables that showed a small correlation coefficient (i.e., less than .20) also showed small differences in their mean and/or proportion, and hence would not be expected to explain any additional variation in price per acre if they were included in a multiple regression. These variables were (X_{30}) increase size, (X_{31}) intend to live on tract, and (X_{32}) electric service available. On the other hand, the variables previously shown with the higher degree of correlations, i.e., (X_{33}) availability of telephone service, (X_{34}) mail route, (X_{35}) school bus route, and (X_{36}) milk pickup route, would be expected to explain at least part of the variability in land prices. That is, one would not be willing to say that the availability of telephone service would increase the value of the farm sixty one dollars per acre. From the respondents' experience, it appears doubtful that an r of the magnitude of these, especially where the large differences in the proportion exist, would be of much use in explaining additional variability in a multiple regression. Before a decision could be made, one would need to know how the additional variable was related to the other independent variables already included in the equation. If it was related to any other independent variable already in the equation, no appreciable amount of variability would be explained by its inclusion.

Biserial correlation. Biserial correlation may be used to analyze continuous variables that have been dichotomized. It differs from the equation used in the previous subsection by its characteristic of being derived from a continuous variable.[3]

The analysis of variables in this section could have been made with simple linear correlation; however, it would have been rather difficult to develop suitable measurements and perform the operation necessary to obtain simple correlation coefficients. Therefore, they were analyzed by biserial correlation since it was simpler to compute and once the relevant important variables were selected from the many possibilities they could be expressed as continuous variables and handled in any manner necessary.

The following independent variables were dichotomized and analyzed by biserial correlation using price per acre and the calculated residual

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[3]The correlation coefficients computed in this section were from the following equation:

$$r_{bi} = \frac{\bar{Y}_1 - \bar{Y}_2}{S_y} \cdot \frac{PQ}{Y'}$$

as the dependent variables:

X_{37} denotes intended intensity of use (full time farming, part time farming, or investment)

X_{38} ownership of all mineral rights

X_{39} presence of a pond on the farm

X_{40} presence of a spring on the farm

X_{41} presence of a well on the farm

X_{42} presence of a creek on the farm

X_{43} presence of a river on the farm

X_{44} presence of water for livestock on farm

X_{45} type of road frontage: no road, gravel roads, dirt roads, two lane asphalt roads, two lane highways, and four lane highways

X_{46} distance of new farm from place raised

X_{47} distance from previous residence

X_{48} tract previously owned by a relative

X_{49} presence of secondary house on the farm

X_{50} presence of silo on the farm

X_{51} presence of milking house on the farm

X_{52} presence of tool shed on the farm

X_{53} presence of chicken house on the farm

X_{54} presence of hog house on the farm

X_{55} presence of pump house on the farm

X_{56} presence of other buildings on the farm

X_{57} presence of fences on the farm

Responses to purpose of purchase and type of road frontage were not dichotomous; however, they were analyzed as dichotomous variables by using the mean and proportion of a given response against the weighted mean and proportion of the other responses. For example, under purpose of purchase the difference of mean of the dependent variable for full time farming and the weighted mean of part time and investment was used. This process was continued until the mean of each response was related to the aggregate of all other means.

The results of the biserial correlation are shown in Table XIII. Low degree of correlation between each of the dependent variables, price per acre and calculated residuals, does not appear to be conclusive evidence that type of road frontage and purpose of purchase would not explain an appreciable amount of the variation of farm land prices per acre. This conclusion appeared justified when one observed the differences in the means and the small number of observations on the extremes. The possibility of attaching weights to these responses will be discussed in the next section. The results for purchase lead to the same conclusions. The biserial correlation coefficient, a rough measure of association, does not appear to be a suitable measure for variables that were dichotomized in this manner.

The accessibility of water has been discussed in Chapter IV. The biserial correlation coefficients indicated which of the sources of water was the most important. The sources of water used in this study were: (X_{39}) pond, (X_{40}) spring, (X_{41}) well, (X_{42}) creek, (X_{43}) river, and (X_{44}) presence of water from any source. The correlation coefficients of the relationship of the independent variables with price per acre ranged from .1118 to .3195. The correlations with the calculated residual ranged from .0428 to .4267. These coefficients indicated that the sources of water were

TABLE XIII

THE MEAN, STANDARD DEVIATION OF MEAN, CALCULATED t, CORRELATION COEFFICIENTS OF INDEPENDENT VARIABLES WITH PRICE PER ACRE AND RESIDUAL, AND RESIDUAL FOR BISERIALY CORRELATED VARIABLES

Variable	N	Mean	Std. dev. of mean	Calculated t	Dependent variable r	Residual r	$\bar{U}$
X_{37} Intended intensity of farming							
Full time farming	39	149.30	63.05		.0462	.1154	- 6.8310 11.1004*
Part time farming	17	173.65	77.66		.2316	.0845	12.256 - 4.172*
Investment farming	7	132.26	84.62		.0603	.0355	11.693 - 1.462*
X_{38} Ownership of all mineral rights							
Yes	57	151.83	66.32	.061	.0061	.0349	- 1.398
No	6	149.38	96.92				9.805
X_{39} Pond							
Yes	17	181.55	70.34	2.103	.2168	.0679	- 3.444
No	46	141.40	65.84				8.610
X_{40} Spring							
Yes	34	159.79	66.35	.904	.1119	.4267	-19.501
No	29	143.29	74.80				15.601
X_{41} Well							
Yes	20	192.63	78.52	2.596	.3159	.3762	-19.736
No	43	138.67	67.98				45.704
X_{42} Creek							
Yes	27	156.17	57.15	.018	.2141	.0428	- 4.825
No	36	155.85	78.22				9.219
X_{43} River							
Yes	15	129.82	69.14	1.524	.1531	.2422	- 2.719
No	48	160.44	67.30				3.683

TABLE XIII (continued)

Variable	N	Mean	Std. dev. of mean	Calculated t	Dependent variable r	Residual r	$\bar{U}$
X_{44} No water available	4	68.30	33.76	4.714	.1397	.2502	-89.058
Water available	59	157.77	66.62				11.542
X_{45} Type of road frontage							
No road	9	105.37	57.43		.1808	.0607	2.613
							-15.677*
Gravel road	18	189.24	76.04		.2931	.1464	17.782
							- 7.679*
Dirt road	5	75.04	28.65		.1703	.1107	4.499
							-66.363*
Two lane asphalt road	14	125.35	53.43		.1620	.1019	4.809
							-16.830*
Two lane highway	15	177.61	76.16		.1758	.0931	13.504
							- 4.597*
Four lane highway	2	337.62	62.38		.0155	.0496	89.777
							- 1.448*
X_{46} Distance from place raised							
0-3 miles	48	149.53	65.36	.538	.0538	.0480	1.660
Over 3 miles	15	160.28	74.21				- 7.936
X_{47} Distance from residence last 10 years							
0-3 miles	50	150.19	66.93	.441	.4200	.0470	2.156
Over 3 miles	13	159.41	68.12				- 8.173
X_{48} Tract previously owned by relative							
Yes	14	174.45	42.48	1.369	.1355	.1253	20.717
No	49	145.70	74.90				- 5.888

TABLE XIII (continued)

Variable	N	Mean	Std. dev. of mean	Calculated t	Dependent variable r	Residual r	$\bar{U}$
Total improvements							
X_{49} Secondary houses				1.554	.1111	.0724	
Yes	6	192.50	70.67				26.377
No	57	147.82	66.66				- 2.749
X_{50} Silo				2.458	.1288	.1350	
Yes	3	245.33	103.11				97.823
No	60	147.42	65.79				- 4.866
X_{51} Milking house				2.712	.2533	.1610	
Yes	3	254.00	98.67				116.597
No	60	146.98	65.35				- 5.804
X_{52} Tool shed				2.503	.2364	.1659	
Yes	12	197.33	98.00				31.784
No	51	141.43	61.64				- 7.448
X_{53} Chicken house				2.741	.2604	.2815	
Yes	12	201.92	95.71				53.908
No	51	140.35	62.97				-12.654
X_{54} Hog house				.930	.0512	.0197	
Yes	4	182.75	108.62				11.830
No	59	150.00	65.36				- .776
X_{55} Pump house				4.325	.3150	.3574	
Yes	6	266.67	126.67				130.031
No	57	140.02	60.30				-13.661

TABLE XIII (continued)

Variable	N	Mean	Std. dev. of mean	Calculated t	Dependent variable r	Residual r	$\bar{U}$
X_{56} Other buildings							
Yes	7	178.86	44.16	1.118	.0814	.0997	32.840
No	56	148.73	69.25				- 4.078
X_{57} Fences							
Yes	43	158.95	52.14	1.173	.1309	.1550	8.569
No	20	136.95	96.94				-17.065

*Denotes sum residual of other groups.

important and therefore should be considered in the multiple regression. However, care should be used to prevent the intercorrelation (if any) of distances to water and sources of water from biasing the interpretation of the multiple correlation coefficient.

The magnitude of the biserial correlation coefficient for the distance to previous residence was .4199 which was relatively high. The difference in the means was $9.22. This would indicate that persons from other areas were willing to pay a higher price for farms than those persons within the area. The interpretation of this variable should consider the intercorrelation of this variable and the variable (X_{30}) intention to increase size of farm. Also it may be that persons outside the area have more disposable income for purchasing farms than the persons within the area, and therefore tend to pay a slightly higher price. Another possible interpretation is that persons within the area have more knowledge concerning farms that are for sale and therefore purchase the available farms before the price determining function of the "market" becomes fully operative for that farm.

The variables in the category of improvements that had the greatest degree of correlation with price per acre were (X_{51}) milking house, (X_{52}) tool shed, (X_{53}) chicken house, and (X_{55}) pump house. The range of the correlation coefficients was from .2364 to .3150. The range of the coefficients for the correlation with the residual were .1609 to .3574. These variables may be correlated with other independent variables in the regression equation; if so, their inclusion in the equation would have little influence on the magnitude of the multiple correlation coefficient. They may provide an indication of the level of development of the farm, i.e., the farms that have these improvements may tend to be the "better" farms and therefore the other variables may express the level of development.

II. SUMMARY

This chapter has shown how correlation coefficients may be computed for discontinuous variables. Those variables that did not have a continuous variable underlying the dichotomy were analyzed by point biserial correlation and those variables that did have a continuous variable underlying the dichotomy were analyzed by biserial correlation. The application of biserial correlation is similar to the problems associated with simple correlation, i.e., the correlation coefficient does not explain all the variability of the dependent variable. Ezekiel has provided two methods of solving this problem. The first method is the inclusion of the discontinuous variables in a multiple regression equation by coding class intervals and using these coded values as a continuous variable.[4] An example of this method designating a code number to the type of roads might be as follows: (1) no road = 10, (2) dirt roads = 20, (3) gravel roads = 30, (4) two lane asphalt roads = 40, (5) two lane highways = 50, and (6) four lane highways = 60. These code numbers would then represent the magnitude of the type of road variable.

The second method for including discontinuous variables in a multiple regression is by using successive approximations.[5] As an example the influence of the "intention to increase size of farm" variable may be measured by the inclusion of the variables in the equation.

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[4]Mordecai Ezekiel, Factors Affecting Farmers' Earnings in Southeastern Pennsylvania, USDA Bulletin 1400 (Washington, D. C.: 1926), p. 46.

[5]Mordecai Ezekiel and Karl A. Fox, Methods of Correlation and Regression Analysis, 3rd edition, John Wiley and Sons, Inc. (New York: 1937), pp. 380-387.

This chapter has shown how influential variables may be isolated and has indicated how they can be included in a multiple regression in order to account for the variability of farm land prices.

CHAPTER VI

SUMMARY AND CONCLUSIONS

I. SUMMARY

It is generally recognized that the variability of farm land prices is large. Land is a basic input factor in farm production and therefore an explanation of this variability is necessary in order to facilitate the decision making process in the farming operation. The specific objectives of this thesis were: (1) to isolate variables that can be measured and used as "explainers" of the variability in farm land prices, (2) use least squares regression techniques in estimating parameters for relevant variables included in a predicting equation, and (3) to present the techniques used in selecting explanatory variables.

The data were collected on a total population of bona fide sales of unencumbered fee simple titles in Jefferson County, Tennessee, during the period beginning July 1, 1955, and ending June 30, 1957. These data revealed a considerable amount of variability in farm land prices. The concepts advanced by economic theory purporting to explain this variability were examined in Chapter II, and found to be impractical to apply because of insufficient data and adequate tools of analysis were not available. The analytical techniques of previous researchers were examined and the limitations noted.

Chapter III was used to discuss the continuous and discontinuous independent variables, their measurement unit, and how they were obtained. Reasonableness and accuracy of measurement were the guides for selection of the possible variables.

In Chapter IV least squares regression techniques were used to obtain parameters for each variable and also to obtain the residual. The residual may result from errors in the selection of the form of the algebraic equation or by excluded variables. Simple linear regression coefficients were computed and recognized as explaining little of the variability of land prices. Those variables that seemed to be curvelinear were then analyzed by a curvelinear equation form and it was noted that the amounts explained were increased in some instances.

Multiple regression was then used to reduce the residual by including the influence of additional variables in a linear equation. The first multiple regression used eleven independent variables that had been mentioned in previous studies. Only 46 per cent of the variability in price per acre was explained by these variables. The second multiple regression used five independent variables denoting value of improvements and only 25 per cent of the variability was explained. The third multiple regression was fitted with five land use variables which explained 45 per cent of the variability. The fourth multiple regression used five land use restrictions variable and explained only 5 per cent of the variability in land prices. The fifth multiple regression considered five independent variables denoting the influence of roads and water; they explained 32 per cent of the variability of farm land values. The sixth multiple regression considered four variables (per cent of farm in improved pastures (X_9), value of improvements (X_{20}), per cent of farm in woodland and wasteland (X_{22}), and per cent of land over 2000 feet from stock water (X_{29})) which explained 53 per cent of the variability. The seventh multiple regression had five independent variables (miles from four lane highway (X_5), per cent of farm in improved pastures (X_7), feet of road frontage (X_{11}), per cent of farm in woodland and wasteland (X_{22}), and per cent of farm over 2000 feet from stock water (X_{29})) that explained 73 per cent of the variability in the dependent variable.

Biserial correlation was used to "isolate" independent variables in Chapter V. The criteria used to select the variable was its correlation with the dependent variable and the residual. Further, the "reasonableness" of the selection was examined. The dichotomous variables that had the highest point biserial correlation coefficients (ranging from .2451 to .2928) were: telephone service (X_{33}), mail route (X_{34}), school bus route (X_{35}), and milk pickup route (X_{36}). Those with the highest biserial correlation coefficients were: presence of pond (X_{39}), presence of spring (X_{40}), presence of well (X_{41}), presence of a creek (X_{42}), presence of a river (X_{43}), distance from place raised (X_{47}), presence of a milking house (X_{51}), presence of a tool shed (X_{52}), presence of a chicken house (X_{53}), and presence of a pump house (X_{54}). The biserial coefficients ranged from .2141 to .4199. Type of road frontage and intent of purchase showed low degrees of biserial correlation. However, it was pointed out in Chapter V that the manner in which the coefficients were computed for these two categories appeared to be unsatisfactory and thus further examination would be necessary in order to obtain conclusive results that these variables would not explain additional variability in farm land prices.

II. CONCLUSIONS

The inferences that can be made about the parameters estimated in various equations in this thesis are limited to the population defined for the acquisition of these data. In other words, the set of parameters obtained for a given equation could not be expected to explain variability in farm land values in another population or area. However, the use of this rather precise definition of the population eliminated the necessity of drawing a sample and any variability present in an estimated parameter was due solely to population variability and not sampling error.

The analysis has shown that there were many variables that contributed to an explanation of at least part of the variability in farm land prices. Least squares regression techniques and biserial correlation appear to be useful tools in selecting relevant variables for explaining a major portion of this variability. Five independent variables provided the best explanation of the variation in land prices when used in a linear equation. These were: distance from a four lane highway, per cent of farm in improved pastures, feet of road frontage, per cent of woodland and wasteland, and per cent of farm over 2000 feet from stock water. The signs of the regression coefficients indicated that the direction of the influence of the variables in the equation were reasonable. The size of the biserial correlation coefficient indicated that some of the discontinuous variables would probably be useful in explaining some additional variability.

A great deal of work remains to be done if a satisfactory predicting equation is to be obtained. For example, different forms of algebraic equations would probably be more descriptive of the underlying relationship. The feet of road frontage mentioned in the previous paragraph could more accurately be described by a curvelinear term in the estimating equation. Furthermore, the relationship of the discontinuous variables with other independent variables would indicate how well these variables would explain additional variation in farm land prices.

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APPENDICES

APPENDIX A

Farm No. ____________

University of Tennessee
College of Agriculture
Dept. of Agricultural Economics and Rural Sociology

Study to determine the influence of various factors on the sales price of land.

Questionnaire

WARRANTY BOOK

Name of Vendee: ____________

Name of Vendor: ____________

Length of Time Owned by Vendor: ____________

From Whom Purchased by Vendor: ____________

Date of Deed: ____________

Date of Recording: ____________

Purchase Price: $ ____________

Terms: (TB) ____________

Value of Stamps: $ ____________

Location of Property:

Block No. ____________ Road ____________

Community ____________ Map

____

____

Size of Tract: ____________ Acres

Improvements: ____________

____

TAX BOOK

Address of Owner: ____________

Address of Tract: ____________

Assessed Value: $ ____________

Annual Tax: $ ____________

APPENDIX B

CONFIDENTIAL

Farm # ____________

UNIVERSITY OF TENNESSEE
College of Agriculture
Department of Agricultural Economics and Rural Sociology

Study to determine the influence of various factors on the sales price of land.

Questionnaire

- -

REMEMBERING THE TRACT AS IT WAS WHEN YOU WERE NEGOTIATING THE PURCHASE PRICE

Purchase price of tract: $____________

Terms: Cash ________ Time payment ____________

Amount of loan $__________ Time to maturity ____________

Bona fide sales? Yes ________ No __________

Increase size of farming unit? Yes ________ No ________

For what purpose was tract purchased?

Full-time farming __________

Part-time farming __________

Residence __________

Investment __________

Other (specify) __________ __________

Did you intend to live on tract? Yes ______ No ______

What type of farming did you intend to follow?

DAIRY	________	FIELD CROPS	________
BEEF	________	TREES	________
SHEEP	________	GENERAL FARMING	________
HOGS	________	OTHER	________
VEGETABLES	________		

Outline the farm boundaries on a soils map.

Soil productivity index: ____________

	Type of construction	Condition	Remaining Life	Size	Value
Dwelling	________	________	________	________	________
Tenant House	________	________	________	________	________
Barn (use ________)	________	________	________	________	________
Barn ________	________	________	________	________	________
Silo	________	________	________	________	________
Milking house	________	________	________	________	________
Tool shed	________	________	________	________	________
Chicken houses	________	________	________	________	________
Hog houses	________	________	________	________	________
Pump house	________	________	________	________	________
Other buildings	________	________	________	________	________
Fences	________	________	________	________	________

Size of farm ____________ acres Amount tillable ____________ acres ______ %

Amount of woodland and wasteland ________ acres ________ % value of timber $________

" " cropland ________ " ________ %

" " improved pastures ________ " ________ %

" " unimproved pastures ________ " ________ %

Amount of level land ________ acres ______ % Slightly rolling ________ acres ______ % Steep ________

Amount of land that can be irrigated ________ acres ________ %

Flowage (other) easement __________ acres

Amount that can be tilled __________ acres

Amount that can be pastured __________ acres

Mineral rights? Yes______ No______

Tobacco allotment ____________ acres

Pond #1			Number of cattle it will supply______
2			" " " " " " ______
Spring #1	Months flowing	__________	" " " " " " ______
2	" "	__________	" " " " " " ______
Well #1	" "	__________	" " " " " " ______
2	" "	__________	" " " " " " ______
Creek	" "	__________	" " " " " " ______

subject to overflow? Yes______ No______

River " " " Yes______ No______

Land within 500 feet of adequate water supply	________ acres	________%
2000	________ acres	________%
over 2000	________ acres	________%

Type of road on which farm fronts:

None__________	2 lane asphalt __________
Improved dirt____________	2 lane highway __________
Unimproved dirt__________	4 lane highway __________
Other____________________	

Amount of road frontage __________________

Distance to nearest road ____________ miles

" " paved road ____________ "

" " 2 lane highway ____________ "

" " 4 lane highway ____________ "

Distance to other employment ____________ "

Distance to primary selling market ________miles

" " " buying market ________ "

" " secondary selling market ________ "

" " " buying market ________ "

Electric service available Yes______ No______

Telephone Yes______ No______

Mail route Yes______ No______

School bus route Yes______ No______

Milk pick up route Yes______ No______

Cost of transporting 100# to market $__________

Distance to school ____________miles

Distance to church ____________ "

Distance to household shopping center ____________ "

Was the purchase price of tract adversely influenced by presence of:

	Yes	No	None present
Beer joints			
Dumping grounds			
Parking area (trespass			
R. R. line			
High tension power line			
Low tension power line			
Telephone cable or line			
Gas line			

How many miles distance is this farm from the place where you were raised? __________mi.

How many miles distance is this farm from the place where you have lived for the last 10 years? __________mi.

Was tract previously owned by a relative? Yes______ No______

What relative? ________________________

#________

If this farm had not been for sale and there had been another farm exactly like it in the next county (or elsewhere), assuming the same distance to market, same services available, and same improvements, etc., how much would you have been willing to pay as purchase price of this other farm?

$______________

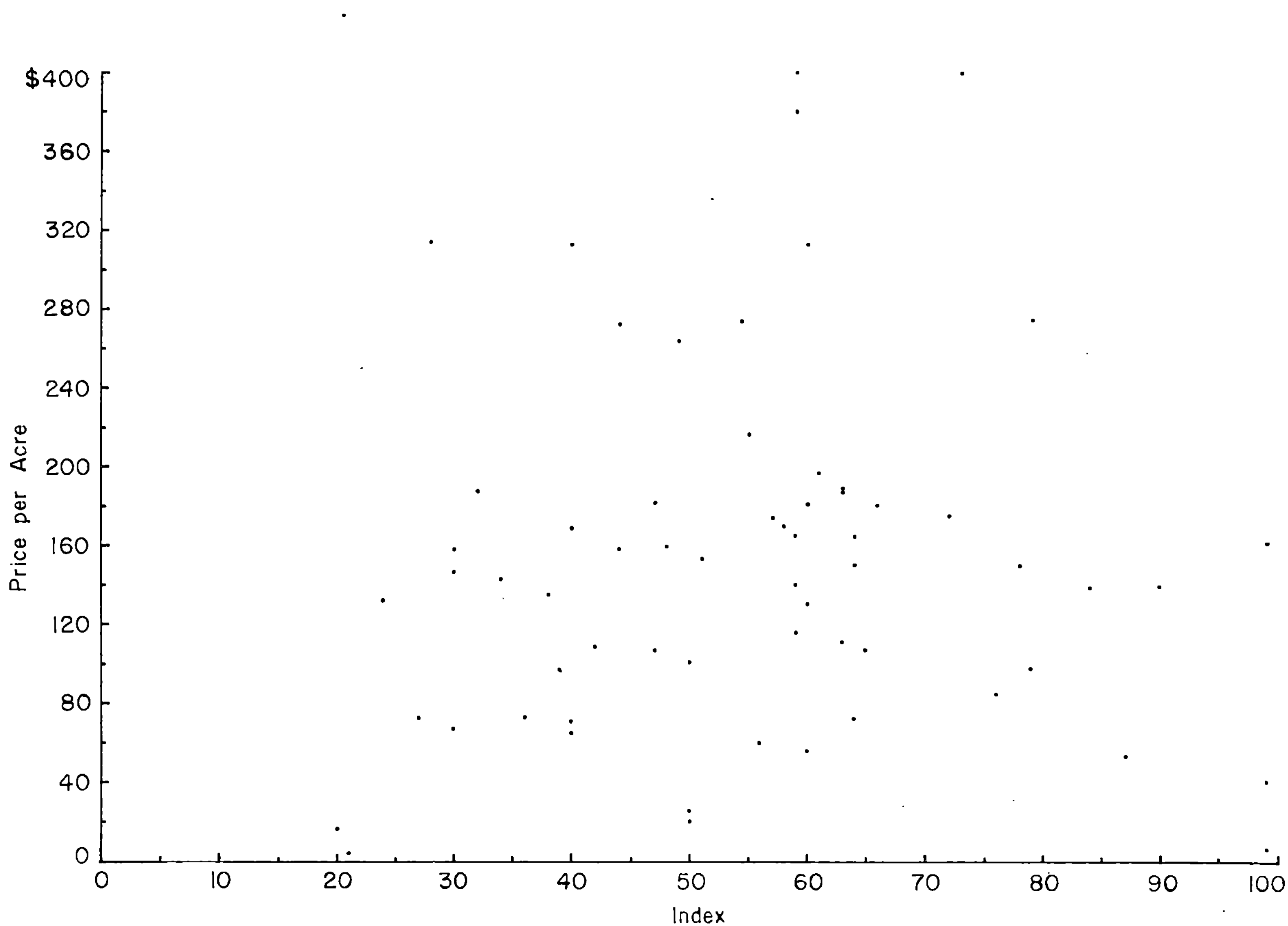
Why? (why this farm rather than another farm?)

What do you expect your net income to be from this tract two years hence?

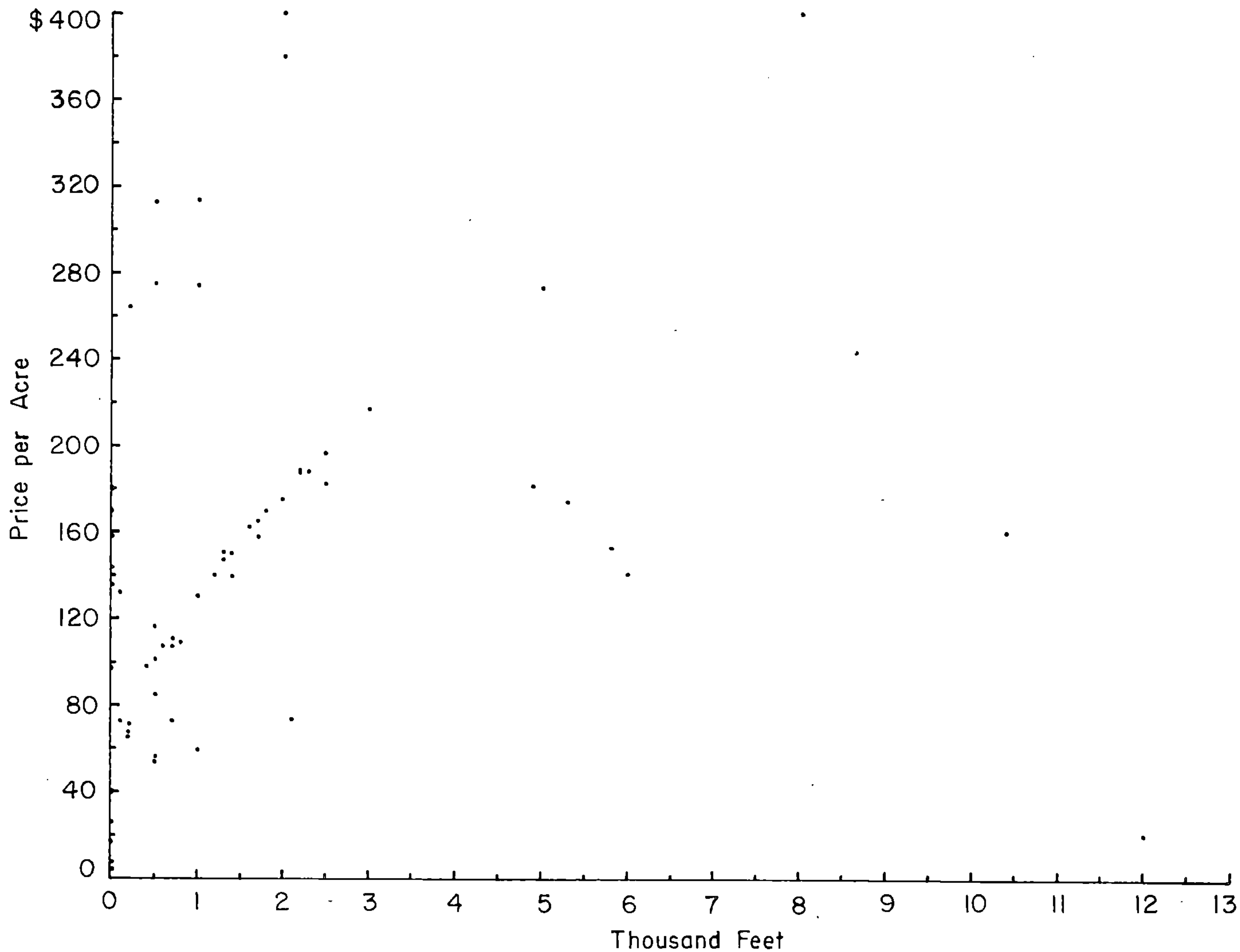
$1000.00	________	6000.00	________
2000.00	________	7000.00	________
3000.00	________	8000.00	________
4000.00	________	9000.00	________
5000.00	________	10000.00	________

How much will be consumed in the home? $____________

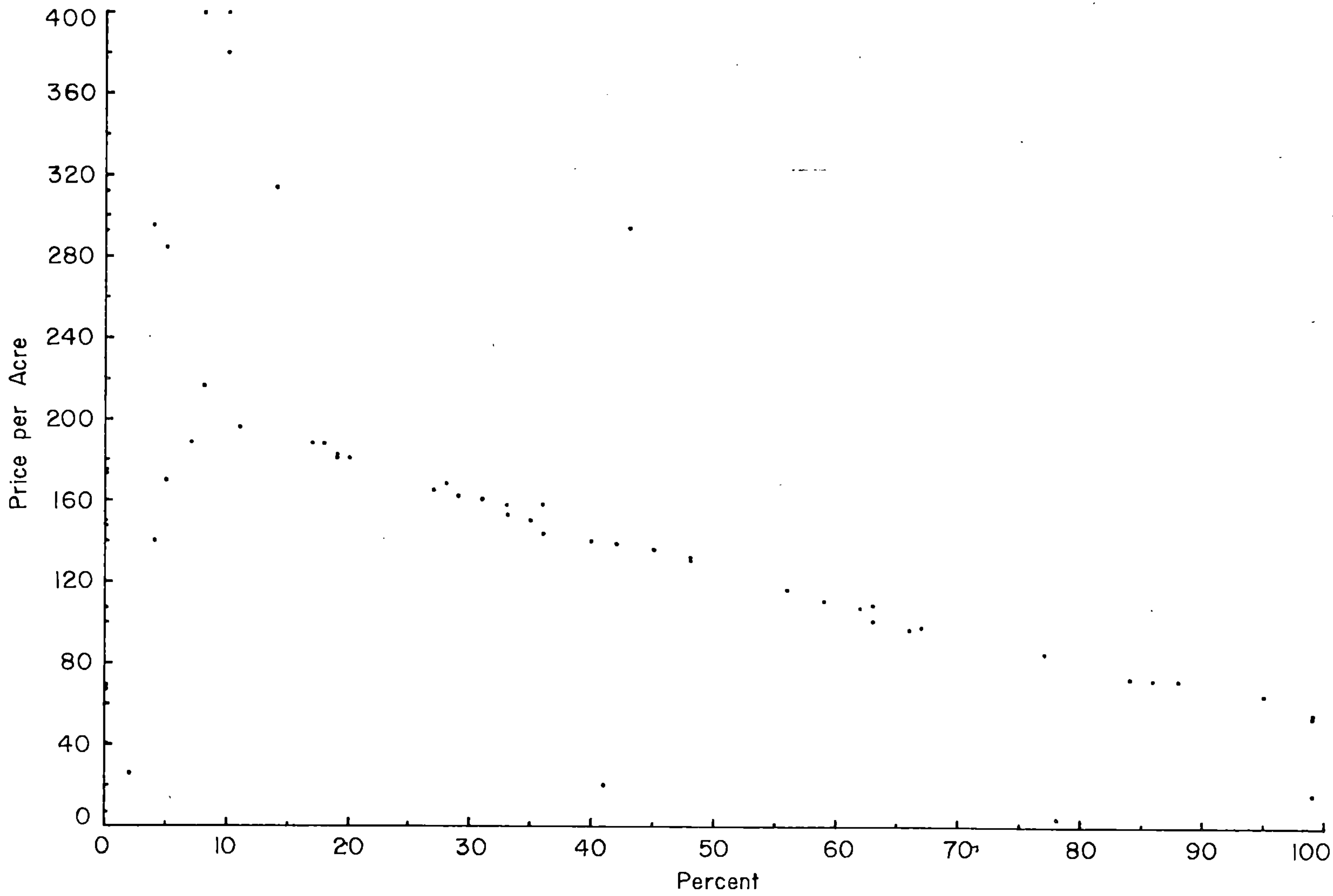
APPENDIX C



Relationship of soil productivity expressed as an index (X_3) to price per acre.



Relationship of feet of road frontage (X_{11}) to price per acre.



Relationship of per cent of farm in woodland or wasteland (X_{22}) to price per acre.

APPENDIX D

INTERCORRELATION AMONG ELEVEN INDEPENDENT VARIABLES AND ONE DEPENDENT VARIABLE USED IN THE FIRST MULTIPLE REGRESSION

	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}
Y (Price per acre)	1.0000	.1174	.1763	.0414	.1057	.1383	.1058	.5681	.5195	.0913	.0847	.2022
X_1 (Value of main dwelling per acre)		1.0000	.5561	.0958	.0527	.2149	.2157	.0420	.2244	.3360	.2965	.1770
X_2 (Value of other improvements per acre)			1.0000	.0329	.0209	.2468	.3114	.0374	.1323	.2910	.2296	.0888
X_3 (Soil productivity index)				1.0000	.0023	.1629	.0987	.0419	.1293	.1943	.0811	.1133
X_4 (Distance to 2 lane highway)					1.0000	.1657	.2250	.0220	.2053	.3317	.1199	.2712
X_5 (Distance to 4 lane highway)						1.0000	.1552	.1147	.2964	.2259	.2446	.2530
X_6 (Acres in farm)							1.0000	.2000	.0087	.2680	.0297	.1311
X_7 (Per cent of farm in improved pasture)								1.0000	.4327	.1272	.0830	.0767
X_8 (Per cent of land less than 2000 ft. of water)									1.0000	.3445	.2593	.3262
X_9 (Per cent of land irrigatable)										1.0000	.0751	.2663
X_{10} (Per mil of farm in tobacco allotment)											1.0000	.1211
X_{11} (Feet of road frontage)												1.0000

INTERCORRELATION AMONG FIVE INDEPENDENT VARIABLES AND ONE DEPENDENT VARIABLE USED IN THE SECOND MULTIPLE REGRESSION

	Y	X_{17}	X_{18}	X_{19}	X_{20}	X_{21}
Y (Price per acre)	1.0000	.3161	.3490	.3490	.4543	.2552
X_{17} (Value of main dwelling)		1.0000	.7910	.7159	.6415	.4144
X_{18} (Value of main barn)			1.0000	.6684	.4642	.3685
X_{19} (Value of other barns)				1.0000	.6580	.3450
X_{20} (Value of total improvements)					1.0000	.6270
X_{21} (Value of total improvements per acre)						1.0000

INTERCORRELATION AMONG FIVE INDEPENDENT VARIABLES AND ONE DEPENDENT VARIABLE USED IN THE THIRD MULTIPLE REGRESSION

	Y	X_6	X_7	X_{22}	X_{23}	X_{24}
Y (Price per acre)	1.0000	.1050[a]	.5682	.4910[a]	.2348	.2554[a]
X_6 (Acres in farm)		1.0000	.2382[a]	.0822	.0786	.0467[a]
X_7 (Per cent of farm in improved pasture)			1.0000	.2382[a]	.1466	.1810[a]
X_{22} (Per cent of farm in woodland and wasteland)				1.0000	.1212[a]	.1679
X_{23} (Per cent of farm in unimproved pasture)					1.0000	.3286[a]
X_{24} (Per cent of farm in level land)						1.0000

[a]Denotes negative correlation

INTERCORRELATION AMONG FIVE INDEPENDENT VARIABLES AND ONE DEPENDENT VARIABLE USED IN THE FOURTH MULTIPLE REGRESSION

	Y	X_{10}	X_{25}	X_{26}	X_{27}	X_{28}
Y (Price per acre)		.0847	.0065	.0730[a]	.0981[a]	.0829
X_{10} (Per mil of farm in tobacco allotment)			.1039	.2736[a]	.1076[a]	.0505
X_{25} (Acres of easement)				.2289	.8168	.1247
X_{26} (Per cent of tillable easement)					.6372	.1415
X_{27} (Per cent of pasturable easement)						.1669
X_{28} (Per cent of land between 500-2000 ft. of livestock water)						1.0000

[a]Denotes negative correlation

INTERCORRELATION AMONG FIVE INDEPENDENT VARIABLES AND ONE DEPENDENT VARIABLE USED IN THE FIFTH MULTIPLE REGRESSION

	Y	X_4	X_5	X_9	X_{11}	X_{29}
Y (Price per acre)	1.0000	.1053[a]	.1381[a]	.0915	.2022	.5174[a]
X_4 (Distance to 2 lane highway)		1.0000	.1657[a]	.3317	.2712	.2056[a]
X_5 (Distance to 4 lane highway)			1.0000	.2259[a]	.2530[a]	.2949
X_9 (Per cent of land irrigable)				1.0000	.2663	.3416[a]
X_{11} (Feet of road frontage)					1.0000	.3257[a]
X_{29} (Per cent of land over 2000 ft. from stock water)						1.0000

[a]Denotes negative correlation

INTERCORRELATION AMONG FOUR INDEPENDENT VARIABLES AND ONE DEPENDENT VARIABLE USED IN THE SIXTH MULTIPLE REGRESSION

	Y	X_7	X_{20}	X_{22}	X_{29}
Y (Price per acre)	1.0000	.5682	.4543	.4910[a]	.5174[a]
X_7 (Per cent of farm in improved pasture)		1.0000	.1556	.3271[a]	.4329
X_{20} (Value of total improvements)			1.0000	.1892	.1927
X_{22} (Per cent of farm in woodland and wasteland)				1.0000	.4379
X_{29} (Per cent of farm over 2000 feet distant from water)					1.0000

[a]Denotes negative correlation

INTERCORRELATION AMONG FIVE INDEPENDENT VARIABLES AND ONE DEPENDENT VARIABLE USED IN THE SEVENTH MULTIPLE REGRESSION

	Y	X_5	X_7	X_{11}	X_{22}	X_{29}
Y (Price per acre)	1.0000	.1381[a]	.5682	.2022	.4910[a]	.5174[a]
X_5 (Distance to 4 lane highway)		1.0000	.1147	.2530[a]	.2575	.2949
X_7 (Per cent of farm in improved pasture)			1.0000	.0767	.3271[a]	.4329
X_{11} (Feet of road frontage)				1.0000	.1354	.3257[a]
X_{22} (Per cent of farm in woodland and wasteland)					1.0000	.4379
X_{29} (Per cent of land over 2000 ft. distant from stock water)						1.0000

[a]Denotes negative correlation