AN ECONOMETRIC STUDY OF FACTORS AFFECTING FARM LAND PRICES, 1940-1977

By

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PREFACE

This study is concerned with determining important factors affecting farm land values in the United States during the period 1940 to 1977. An econometric model is specified to accomplish this objective. The model is capable of expressing some factors as having effects for only one period and other factors having multiple-period effects by the use of Almon's polynomial distributed lag procedure in association with ordinary least squares estimation. Significant difficulty was encountered during model estimation because of multicollinearity high correlation coefficients between several of the explanatory variables. Consolidating a number of factors included in the original model reduced the multicollinearity problem.

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NOMENCLATURE

USINDEX	U.S. Index of Farm Real Estate Prices
RINDEX	deflated Index of Farm Real Estate Prices
NETIFF	nominal net income from farming
RNETIFF	deflated net income from farming series
RCG	capital gains in real (deflated) terms measured by Index changes
RGOVPTS	government payments in real (deflated) terms
RINC	deflated net income from farming less direct government payments
ALTRET	rate of return on alternative investments
GOVCON	government contribution to farm income
URBAN	series representing percent of total U.S. land area occupied by Standard Metropolitan Statistical Areas
UNEMP	national rate of unemployment
SPSA	Standard and Poor's 500 Stock average
SDIV	average common stock dividend
POP	U.S. population
TAXES	farm real estate taxes per acre
OPIP	agricultural output per unit of input
INTRT	mortgage interest rate
CPI	Consumer Price Index

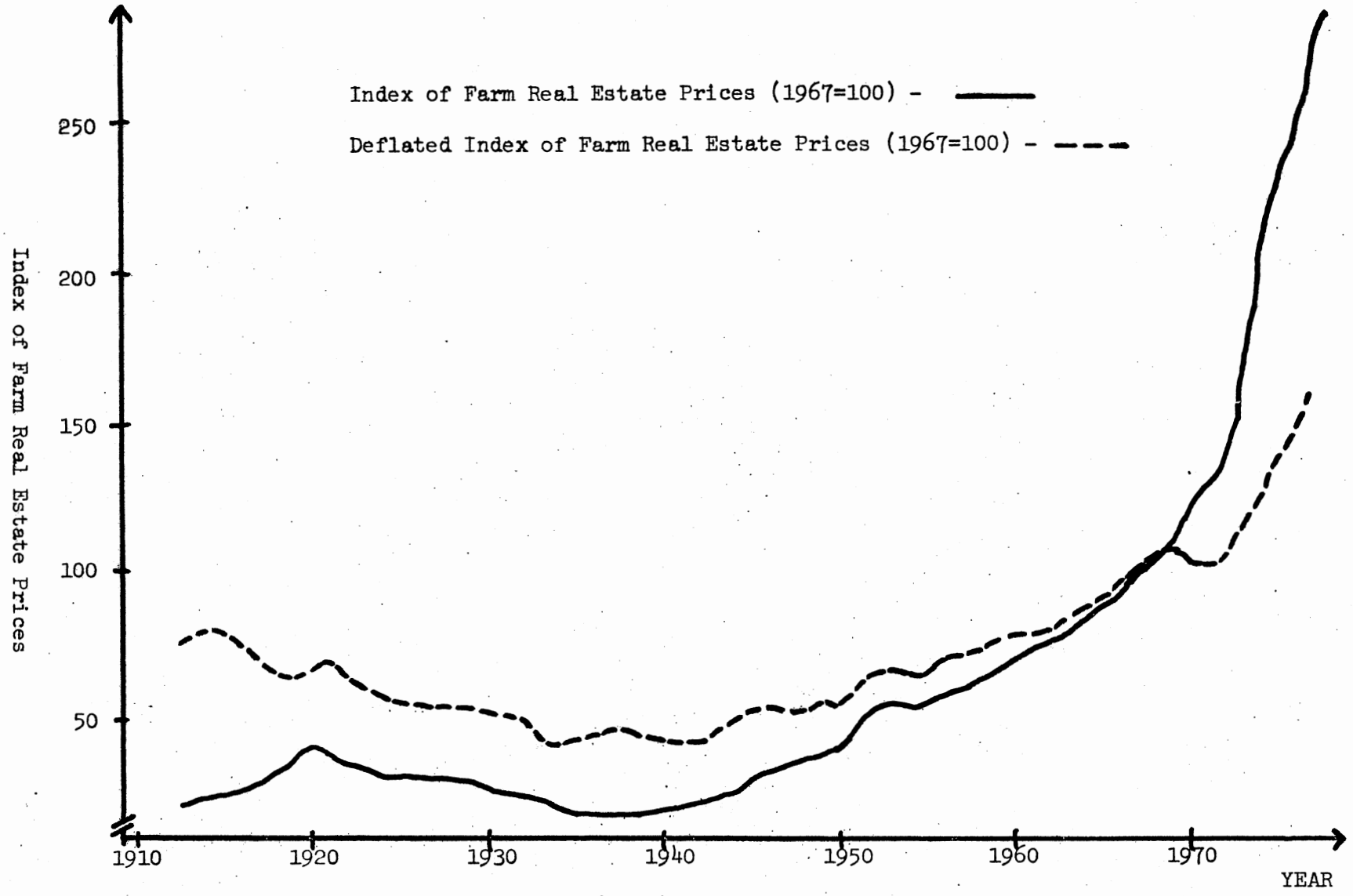
CHAPTER I

THE RESEARCH PROBLEM

Introduction

The total value of farm real estate, including buildings and improvements, reached 497.2 billion dollars at the end of 1977.[1] The United States Department of Agriculture has predicted that this figure will rise to almost 550 billion dollars in 1978.[2] Currently farm real estate is agriculture's most price-sensitive long-term asset. Farm land, when properly managed, does not depreciate but rather remains productive for an indefinite length of time. Therefore it has long been and will likely continue to be the most important single physical asset in the farming sector.

Because the value of farm land is so price-sensitive, it is instructive to trace the changes in value which have occurred in the past. Figure 1 depicts the Index of Farm Real Estate Prices since 1910 both in nominal and in real terms. Key features of this figure are the sharp rise in value during World War I, the equally sharp break in prices following the war, the gradual decline ending during the depression years, and the resulting rises following those years. During World War II prices began a rise which has been interrupted only twice. The 1940-1977 advance represents a compound rate of increase of 7.6% per year. The real Index, in Figure 1, is the nominal



Source: Clifton and Crowley (1973) and Statistical Abstract of the U.S., various issues.

Figure 1. Farm Real Estate: Index of Average Value per Acre (Deflated and Nondeflated), 1910-1977, Deflated by the Consumer Price Index (1967=100)

Index deflated by the Consumer Price Index. This deflated series compares farm land value changes to changes in the general price level, represented by the Consumer Price Index. Thus, to the extent that the Consumer Price Index represents the true price level in the economy, the deflated index shows changes in the real wealth position of owners of farm real estate. The annual compound rate of increase above inflation (the general price level) has been 4.5% during the 1967 to 1977 time period. These are truly significant gains in purchasing power and represent significant increases in the wealth position of agricultural land owners.

Recently, farm land price increases have been the most dramatic. From March 1, 1972 until February 1, 1978, the average value per acre of land and buildings has increased from $219 to $490. This increase represents an annual compound rate of increase of 14.4 percent. In certain areas the increases in value have been even more spectacular. For example, during the same period average Illinois farm land price has increased from $522 per acre to $1,581 per acre. This represents an annual compound rate of increase of 20.3 percent.

The value of farm land has always been of interest to those directly involved in agriculture. Farm and ranch operators have traditionally been most interested in land prices. The prevailing price indicated to the potential buyer the cost of entering farming as a land owner or, in the case of the established farmer, the cost of expansion. Operators who own at least a portion of their land have observed land prices closely because of the effect on their wealth positions. Increases in the prevailing price of land result in corresponding increases in the owner's equity position. These increases can be realized directly by

sale of the land or indirectly through increased liquidity or by use of the increased equity as collateral for expansion loans.

As a consequence of the large farm land value increases since 1972, owner's equity in farm real estate has more than doubled. Farm real estate equity increased from 209 billion dollars in 1972 to over 440 billion in February of 1977 and exceeded 480 billion in February of 1978. Since the majority of farm land is owned by farm operators, much of this increased equity has been realized by farm operators.

Off farm investors are interested in the recent changes in farm land values because some investment portfolios include land as an important element. Recent increases in farm land value have outstripped unusually high inflation figures which has made land an excellent inflation hedge for any category of investor. Farm real estate lenders are sensitive to changes in farm land values because higher values strengthen old loan positions but may tend to jeopardize the cash flow of new or more recent loans.

The public in general is interested in the effects of farm land price escalation for at least two reasons. First, recent price increases have virtually eliminated from the land market young farmers and other potential bidders with low equity positions. The bidder most capable of purchasing available farm land is the established farmer with a high equity position and with significant scale economies expected to be realized from a purchase. In the case of established operators, present operations can often provide cash to meet the debt obligation during the deficit cash-flow years.

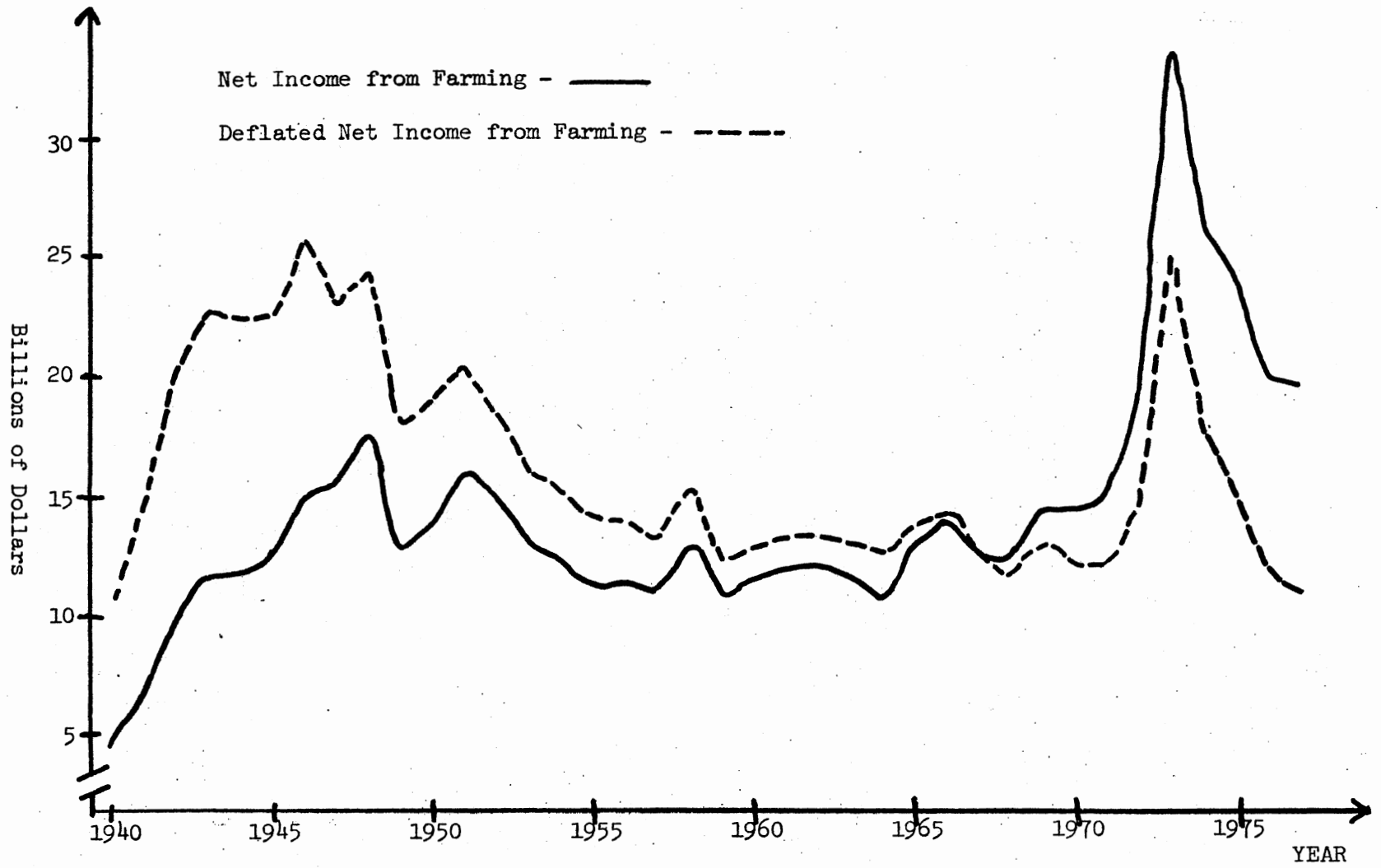
Because over 60% of current farm land transfers are from one farmer to another farmer, a significant change in the structure of farm

land ownership may be occurring. If the most competitive bidders for farm land are current land owners, there is a possibility of creating a "landed" class of farmers, small in number but large in percentage of land owned. This possibility, in the face of government's often stated objective of retaining an agriculture structure of "family" farms, is one of the policy implications of continued increases in farm land values. A possible effect could be the establishment of farm and non-farm families with very large land holdings along with many tenant families.

Another public interest issue is that the escalation of farm land prices will eventually be felt at the supermarket. Capital, even land, a residual claimant of income, must earn a return on its value. As the cost of land increases, the long term result may be a gradual but significant increase in the price of food to the consumer. The relationship is a direct and immediate one if farm commodity price supports are based on production costs including land costs.

Background

The sharp rise in farm land values since 1972 has occurred in the fact of highly variable net farm income. Net farm income has ranged from an all-time high of over 33 billion dollars in 1973 to near-depression (in real terms) levels in 1976 and 1977. Since the peak year of 1973, farm income has dropped sharply in response to much lower crop and livestock prices. Figure 2 depicts net income from farming data for each year from 1940 to 1977. The current dollar income series shows a quick rise to nearly twelve billion dollars in the early 40's followed by a long period (29 years) of quite stable incomes. During



Source: U.S. Department of Agriculture, Farm Income Situation, various issues.

Figure 2. Net Income from Farming, 1940-1977, in Current Dollars and Deflated by the Consumer Price Index

this period the highest reported income was 17.7 billion dollars in 1948 and the lowest 10.5 billion in 1964. Average annual income was 13 billion dollars during the 29-year span. Income rose to 18.6 billion dollars in 1972 and then skyrocketed to over 33 billion in 1973 in response to large commodity price increases. Since 1973, incomes have dropped sharply to near 20 billion dollars for the last three years.

Income in deflated dollars adds detail to the current-dollar picture. In terms of purchasing power, the rise in farm income in the early 40's was substantial. Starting in 1942, real farm income exceeded 20 billion dollars for seven straight years reaching an all-time high income of nearly 26 billion in 1948. Real income dropped substantially after 1948 and averaged only 14 billion dollars for the next 23 years, reaching a low of 11.8 billion in 1968. Then real farm income rose somewhat in 1972 and spectacularly in 1973 to 25 billion dollars. After 1973, the real drop in income is more precipitous than the current dollar incomes show, from 25 billion dollars in 1973 to less than 11 billion in 1977, a 56% decrease in real income.

Until the early 1950's changes in farm land values closely paralleled changes in farm income. Low income years, such as 1920 to 1933, generally showed a few small rises but predominantly land value declines from year to year. However, during the 1942 to 1948 period, farm income was at a very high level and farm land values rose in response. In the early '50's, farm land values began a gradual rise interrupted only twice with slight declines in 1950 and 1954. Real net farm income stabilized during the 1954 to 1972 period at an average of 13.3 billion (1967) dollars, about 10 billion less than the average during the war and post-war years of the '40's. With this reduced

income at very stable levels, one would expected farm land values to stabilize in keeping with past market performance. However, farm land values continued an upward spiral rising from an average of 83 dollars per acre in 1954 to 219 dollars per acre in 1972, a compound rate of increase of 5.6% annually. This departure from the previous pattern of parallel land value changes and farm income levels raised questions among researchers as to factors other than income which influenced land values or, more precisely, land market price.

Even as these other factors contributing to farm land values were being considered, a new era of price increases began. Net farm income reached its highest nominal value in 1973 and was just short of the highest real income on record. From this record high, farm income dropped considerably from 1974 through 1977. Real income in 1977 was only 10.9 billion dollars (1967), the lowest in 37 years. Meanwhile, farm land values increased sharply during 1973 (24.7 percent) perhaps in response to very high commodity prices and resulting high income. However values did not decrease with the income decline but rather continued to rise (11.9% in 1974, 13.6% in 1975, 16.9% in 1976 and 8.8% in 1977). The rate of increase slowed somewhat but the resulting capital gains were still very substantial. For example, real net income was 10.9 billion dollars in 1977 but real capital gains were nearly two and one-half times that level, 25.3 billion dollars. It is difficult to predict the effect of this situation on the future structure of agricultural land ownership.

What factors caused land values to continue to rise both in nominal and in real terms? At first, farm land values rose with rising incomes in the '40's. When income stabilized at relatively low levels

during the '50's and '60's, land values continued to rise at a rate above the inflation rate. Then, starting in 1973, land values skyrocketed perhaps in response to a record income year. Although income has dropped sharply since 1973, land values have only slowed their rate of increase, softening substantially in isolated areas. Thus, income from production seems to be only one factor causing changes in land values.

Problem Statement

Models proposed for projecting farm land values in the past have worked well for the time periods for which they were estimated but have not predicted well outside their sample years (Kramer et al, 1977). Reestimating the models for later time periods has caused many sign and coefficient changes within the models indicating, perhaps, true changes in factor coefficients and elasticities. This study will explore farm land value trends since 1940 and identify the significant factors affecting land values during that time period with special attention given to factors contributing to the tremendous farm land price increases since 1973.

Review of Literature

This study is concerned with changes in the price of agriculture's primary capital asset, farm land. Farm land price changes, particularly the large increases occurring in the last five years, have generated huge unrealized capital gains for land owners. As mentioned earlier, real capital gains from land price escalation were over twice the level of farm income in 1977. The dollar value of these gains has repercussions

throughout the agricultural industry.

Capital Gains

The capital gains question was apparently first formally explored for the agricultural sector in 1960. Grove (1960) discussed methods of estimating capital gains for the average farm. The inclusion of capital gains as an additional return to farming was being discussed at that time. Grove felt that capital gains could be estimated accurately enough to produce a more complete picture of returns to farming.

Boyne (1964) studied changes in the real wealth position of farm operators for a twenty-year period (1940-1960). Capital assets were separated into four categories; farm real estate, machinery and motor vehicles, livestock inventories, and crop inventories, all of which he classified as price-sensitive assets. Using the USDA Farm Family Living Index to represent the general rural price level, he estimated true purchasing power gains over the time period. Boyne concluded that returns from these nonconventional sources contributed to the welfare of the owner and were a part of the return to the investor. This suggests that anticipated capital gains may be a major element in determining farm land prices.

Bhatia (1969) presented alternative methods for calculating capital gains and losses. He separated his calculations into classes of assets similar to Boyne in the earlier study. Bhatia concluded that capital gains had been quite large relative to conventional measures of farm income, up to 50 percent of farm income in some years.

Bhatia (1972) discussed capital gains and the consumption function for the entire economy. For the economy as a whole, he showed that

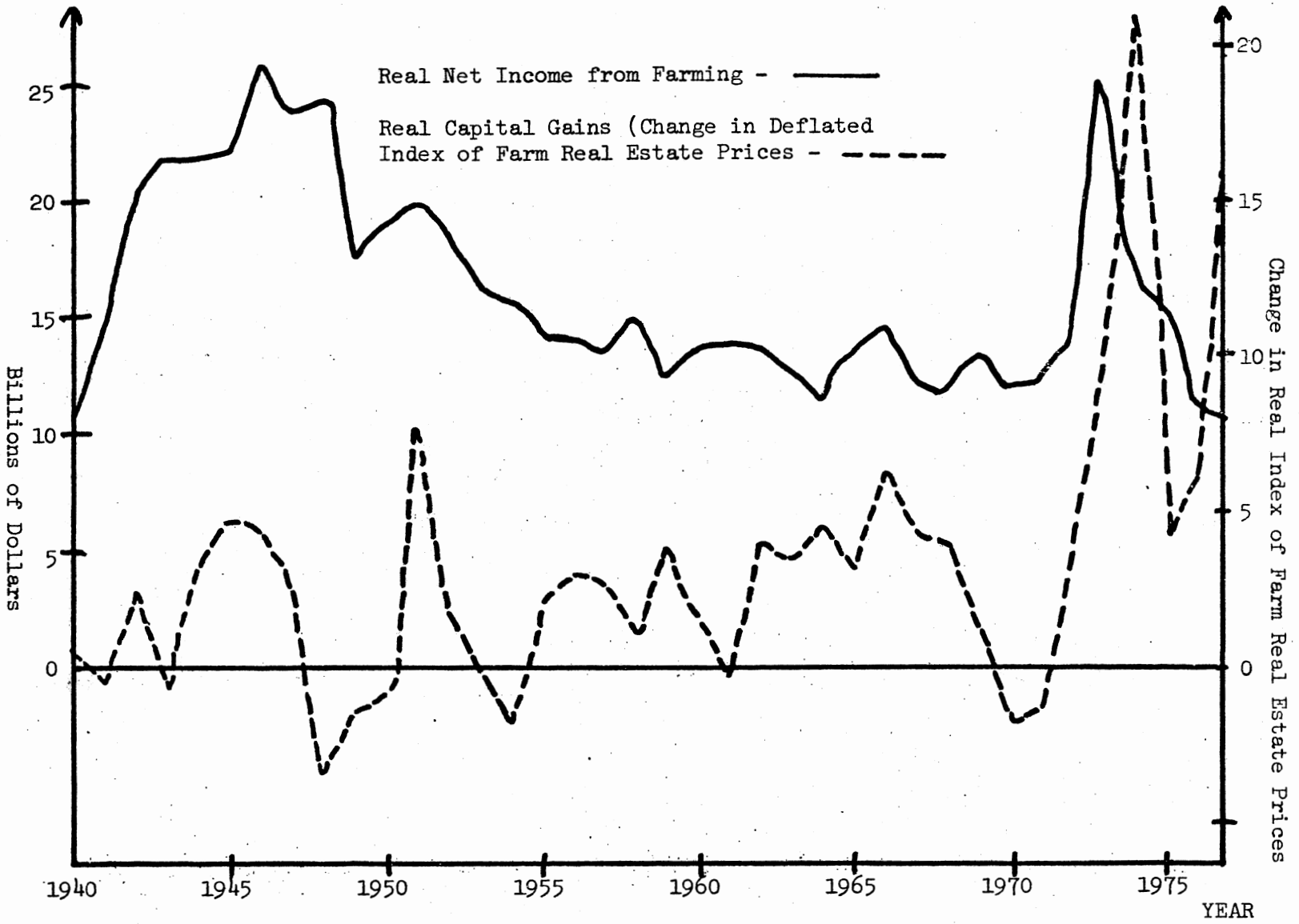
capital gains, both realized and accrued, affect consumption significantly. He found that people treat realized gains like other income. His analysis did not include specific reference to the agricultural sector which has had greater per capita gains than the economy as a whole.

Land Prices

The farm real estate category of farm assets has shown by far the most significant capital gains since 1940. This study is therefore concerned with capital gains of farm land owners caused by land price increases. Past research has been directed toward predicting land prices, both directly and indirectly. Several methods have been used, each producing good results for the time period covered by the study.

More recently, two general methods have been used to predict farm land prices, single-equation models and systems of simultaneous equations. The theoretical basis for each method will be discussed later. It has been apparent that single equation prediction of prices has been more accurate. However, parameter estimates have not been as precise as those derived from simultaneous system estimates. Because the simultaneous system of equations is more structurally sound, parameter estimates are generally more accurate.

Until the late 1940's farm land value changes had closely paralleled changes in farm income. Figure 3 shows the extent of this situation. However the income decrease at the end of the '40's and the continuation of farm land price increases raised questions as to the level of land price that current income warranted. Larsen (1948), assuming the capitalization rate as the average farm mortgage interest rate plus



Source: Clifton and Crowley (1973) and Statistical Abstract of the U.S., various issues.

Figure 3. Net Income from Farming and Change in U.S. Index of Farm Real Estate Prices, 1940-1977

one percent and a scheme of capitalizing future rents to present value, developed values that land income "warranted." At that time, future income was the only factor researchers hypothesized to affect land values. As an aside Larsen mentioned the possibility that land purchased to round out an inefficient farm unit might warrant a price higher than current and future income would ordinarily warrant. This is the first reference to factors other than income affecting land values.

As income from farming stabilized and even declined in the early '50's, farm land prices continued upward. Renshaw (1957) explored the possibility that gross farm income could better predict land values. He used a scheme of declining weights for previous years to determine the independent variable for his first model. In subsequent models he incorporated a time trend and the prevailing mortgage interest rate. His summary suggests that some historical relationships may not have been operating in the market at that time and that other variables, possibly non-agricultural income, may have been affecting the land market.

Klinefelter (1973) developed a single-equation model to explain land prices changes in Illinois for the period 1951-1970. His work showed that the most significant factors affecting land values during that time were expansion pressure, government program payments in conjunction with technological advance, and the rate at which income is capitalized into land values. He also suggested that expectations of capital gains had contributed to the demand for farm land as an investment. His model exhibited serious multicollinearity problems. His solution was to reduce the number of factors hypothesized to affect farm land prices. The factors he dropped had "wrong" economic signs

and were not statistically significant.

A single-equation model was also proposed by Duncan (1977). His analysis concluded that farm enlargement pressure, farm income, and capital gains expectations were the major factors affecting land prices. In his study, Duncan used deflated (inflation adjusted) independent and dependent variables.

In a more recent analysis, Kramer et al (1977) modified and re-estimated the Klinefelter model using U.S. data. Using a 1913-72 data series, the modified model showed illogical signs for net farm income and average farm size. Using 1946-72 data series, the income and farm size signs were correct but the transfers sign changed. However, the model predicted well (R^2 = .982) even with those problems. Kramer and his associates compared estimation techniques to determine how models estimated before the present time predicted outside their sample periods. Their single-equation model was the modified Klinefelter model which, as they recognized, has less structural validity than the simultaneous system models, but predicted well.

Three studies have used systems of simultaneous equations in different ways to analyze land price movements. Herdt and Cochrane (1966) specified a three equation system; a demand equation, a supply equation, and an identity (supply=demand). Using this format, they concluded that the primary determinant of land prices was technological progress coupled with a government price support system. They hypothesized that technological progress reduced cost of production and, with commodity price supported above competitive equilibrium, caused higher than "normal" income, with the increased income being quickly capitalized into land values.

Reynolds and Timmons (1969) used a two equation recursive format to analyze the 1913-66 time period. Their study suggested that the principal determinants of farm land prices were expected capital gains, predicted voluntary transfers of farm land, government payments for land diversion, conservation payments, farm enlargement, and rate of return on common stock. Their approach was to first predict voluntary transfers and then land price in a recursive manner.

Tweeten and Nelson (1966) used a five equation model to analyze the 1923-1963 time frame. Principal determinants of farm land price suggested by their study were capitalized benefits from government programs tied to land and pressures for farm enlargement. Other significant variables included use of farm land for nonfarm purposes and changes in other variables associated with changing farm-nonfarm economic relationships. They estimated that speculation in farm land contributed about one-sixth of the variation in land prices during the 1950-1963 period.

Tweeten and Martin (1966) published essentially the same model, the five-equation system, as a journal article. Their purpose was to explain the reasoning and methodology of the model rather than to analyze land prices. Various estimation techniques, each used in estimating the model, were discussed as to advantages and disadvantages. Each method seemed to enjoy certain advantages and to suffer some disadvantages compared to the other methods. The three techniques used were ordinary, recursive, and autoregressive least squares.

White et al (1977) reestimated the Tweeten and Martin (Nelson) model using more recent data (1960-74). Their results suggest that the importance of farm enlargement has declined relative to earlier

periods. Important variables seemed to be net farm income, returns on common stock and land in farms. They concluded that linkages between farm land and nonfarm investments are becoming more important.

Hauschen and Herr (1977) used the Almon polynomial distributed lag to weight past incomes in order to measure their effect on present farm land prices. They concluded that the primary determinants of farm real estate values in the past 38 years were net returns to farming, technological advance, and nonfarm demand for land. Interpretation of the lag coefficients showed that any one year's farm income will be felt in farm land price movements for as long as the following five years. The authors concluded that land prices may continue to advance in the face of falling incomes because of higher incomes of earlier years, technological advancement and nonfarm demand for farm land.

Plan of Study

Chapter II presents a discussion of the investment qualities which farm land embodies. The market for farm land is then explored with attention to its unique characteristics and the economic model is developed. Each variable and its hypothesized effect is discussed. In Chapter III, the statistical model is proposed with special attention devoted to the polynomial distributed lag procedure. The data series used to represent the different variables is discussed and sources and limitations of each data set are reviewed. The empirical results are presented in Chapter IV. Last, the summary, conclusions, and implications are presented in Chapter V.

CHAPTER II

THEORETICAL CONCEPTS

Farm Land and the Farm Land Market

Farm real estate is a unique commodity with qualities satisfying many wants and needs. Farm land is a major input in the production of agricultural commodities which are sold to generate income for the seller. This production is not a one-time occurrence but production over time. Thus, farm land provides a flow of services which produce income for the owner through many time periods. The value of farm land for production is the sum of future returns to the land into perpetuity discounted to the present. This value is derived by using the classical capitalization formula.[1]

The resulting value depends on two factors, the annual return and the capitalization rate. An increase in the annual returns and/or a decrease in the capitalization rate will cause the value to be higher. A decrease in the returns and/or an increase in the capitalization rate will cause a lower value. Since the production of income from agricultural products is not certain and there is even greater uncertainty about future prices and yields, the prediction of future annual income is very dependent upon the expectations of the buyer. If all other factors are equal, the buyer with the highest expectations of future

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[1] $V = \frac{R}{i}$ where V=dollar value, R=annual return, i=capitalization rate

incomes will usually bid the highest price for the right to those future returns.

The other variable affecting the bid price under this valuation model is the capitalization rate. The choice of a capitalization rate has a great deal to do with bid price but little is known about each buyer's decision process concerning the determination of the capitalization rate. The rate embodies many of the variables which affect financial decisions but these variables are so intertwined that specific changes in the rate due to one variable are difficult to trace.

The use of the traditional capitalization formula does not seem to fully explain movements in farm land prices since the early 1950's. As pointed out earlier, farm income leveled off, and may have declined in real terms, but land values continued to rise. What other qualities may land have that could explain this divergence? Perhaps because of its permanency, land has traditionally been treated as a store of value, a hedge against inflation. Land values have increased at a rate greater than the inflation rate, particularly in the last five years. This expectation of land value changes at least as great as the level of inflation transfers some of the economic prosperity of the nonfarm sector to the farm sector. This may buoy land values during periods of farm sector depression.

Succeeding generations of farmers must recognize, however, that higher farm land prices increase the real cost of producing farm commodities. The higher costs resulting from high land prices reduce the amount of farm income left for consumption by future generations, unless commodity prices increase accordingly.

Not only does land have surface production potential for agriculture

products, it may also produce valuable minerals from beneath the surface. Particularly during a period of energy shortages and of renewed interest in alternative sources of energy, fossil fuel deposits beneath the surface may be extremely valuable. However, in this study only the price of the surface rights to land is considered.

Land may be purchased for consumption rather than for production. In today's society, vast expanses of land area are needed to house, entertain, and transport a growing population. Many areas formerly used for farming have been converted to residences, airports, parks, lakes and reservoirs, factories, offices, wholesale and retail establishments, and transportation facilities. The spatial uniqueness of land dictates that the land nearest these higher-intensity uses be included in the expansion. Thus, prime farm land is used as well as poorer non-productive land. Gale (1963) observed that, in 1963, over 20% of the U.S. land area lay within 30 miles of a metropolitan area. Since that time, urban sprawl appears to have accelerated, raising the percentage significantly.

Thus farm land can fulfill many needs for many people. A single parcel of land may potentially be used in agricultural production, as a resort lake, country home, office building, or one of any number of other uses depending on many economic and social circumstances. There are many factors less tangible than physical attributes which contribute to market price but are difficult to quantify for economic analysis. Among these other factors, particularly in this country, are tradition, social values, and beliefs about land. These factors tend to add complexity to our analysis of farm land value changes. The objective here is to quantify as many of these variables as possible

and to measure their effect on changes in the price of farm land.

A unique characteristic of farm land is the manner in which ownership is transferred. A perfectly competitive market, by definition, requires trading a homogeneous commodity, perfect information exchange, bidding and negotiation by competing buyers and sellers, etc. The land market has few of these attributes. There are no centralized markets or even county markets. Transactions occur in thousands of local markets where knowledge outside the local area is quite limited and bidding, while usually competive, may not include buyers from outside the area. Land is not a standardized commodity. Each plot has its own unique characteristics which enter directly into the bidding and selling process. Fertility of soil may vary widely, even among different areas of the same parcel. Other productive resources may exist on the land such as timber. The parcel may even have great esthetic value which is bid into the exchange price.

On the average, only 3-4% of total farm land in the U.S. changes hands each year. Because of low rate of land turnover, potential buyers may treat the offer for sale of a contiguous or choice parcel of land as a once-in-a-lifetime occurrence. Thus, factors other than purely economic factors may outweigh a price derived by economic analysis. Many of the qualities mentioned earlier may enter into the bidding, overshadowing the agricultural income-producing potential of the asset.

The Economic Model

The value of a capital asset is the sum of all future returns discounted to the present. Thus, factors which affect farm land values must in some way affect either future returns, future costs, or the

capitalization rate. Therefore each factor to be specified as economic factors serve to increase future returns, reduce future costs, or to change the capitalization rate used to discount future net returns.

Income

Income production is, of course, the primary theoretical factor in the determination of farm land prices. Ownership of farm land entitles the title holder to the receipts of production. Therefore, any farm land value examination requires the inclusion of an income component *per se* in the model. But how long does the income in a particular year in the past affect changes in farm land values?, one year, five years, ten years? This is a difficult question to answer. It seems plausible to hypothesize that the income for any one year affects farm land values for several years in the future.

The permanent income hypothesis might suggest that a certain level of income is expected during any period. Deviations from this income on the high side may perhaps cause a greater proportion of net income to be allocated to land. Incomes below the expected income may reduce both the allocation to land and consumption during the period.

Income-Affecting Factors

Income received because of the productive qualities of farm land has been hypothesized to affect the price of land the buyer is willing to pay. The interaction of many factors affects the ultimate return to land. In this section factors which directly affect residual income to land are discussed. By affecting income, these factors have an indirect effect on land prices in the long run.

Productivity and Consolidation. Technological advance has been used in previous studies as a primary factor in farm land price determination. This technology has been of a capital-using nature. Consequently, the adoption cost to the individual farmer has been high. These costs usually become fixed costs to the operator once the equipment purchase is made. It is often to the operator's advantage to spread these fixed costs over a larger acreage either through leasing or purchasing other plots. The final result is that the benefits of the technological change are bid into higher lease and land purchase prices leaving the greatest returns to the early adoptors. Technological advances typically add demand pressure and cause positive movement in land prices. A corresponding increase in the average size of farm resulting from the technological advances also appears plausible.

Government Payments to Farmers. Herdt and Cochrane (1966) discussed technological change in an environment of government-supported prices. Only in such an environment will long run excess profits be generated to be capitalized into land values. Without government price support programs the new technology will lower costs, causing larger production and lower prices. Boehlje and Griffin (1975) suggested that government payments provide a floor for prices and, in that sense, reduce the variance of income to farmers. Government payments provide positive impetus for land prices by affecting both elements of land valuation, net returns and the capitalization rate. Support prices increase annual returns during periods of low commodity prices and, by reducing both the variance of income and risk, lower the effective capitalization rate. Thus it is hypothesized that government payments to farmers affect farm land prices.

Taxes on Real Estate. Real estate taxes are a production cost. These costs, classified as fixed costs for accounting purposes, must be paid even if no income is generated by the land. The burden of the tax falls only to the owner of the land and is a direct cost to him. Therefore, it is hypothesized that the farm real estate tax burden is a factor in determining land values. An increase in farm land real estate taxes would be expected to exert a negative influence on land values.

Demand for Food. Tweeten (1970) suggests that demand for food at the national level in the United States is quite income inelastic (about .15) Therefore, the large income increases experienced by Americans have not been transformed into significantly greater food purchases. However, feeding more people, both in the U.S. and throughout the world, increases the demand for food by increasing the number of consumers. It is therefore hypothesized that an increase in the demand for food will ultimately be capitalized through income into higher land values.

Reduced Acreage of Available Farm Land. A reduction in the acreage of farm land will have both a direct and indirect effect on land values. The reduced acreage will, to some extent, reduce total production from agriculture. Large decreases could actually reduce production sufficiently to raise commodity prices. The price increases would probably increase income and, subsequently, land values. Land lost to urbanization or certain other reasons is land lost forever to production agriculture.[2] The indirect effect may be psychological

[2]Other "lost acreage" includes parks, highways, reservoirs, etc.

relating to demand for space. The cliche, "they're not making any more land," applies to land in total if not to farm land itself.[3] Thus, a reduction in available open space may spur demand for land of an off farm nature. Off farm demand for land, not including investment demand, may be described more fully as demand for consumption. Hobby farms, rural residences, "tramping grounds" in the country, etc., may accentuate off farm demand at the outer fringes of metropolitan areas. It may be said that the demand for land purchased for consumption is nearly perfectly inelastic. Therefore, it may be hypothesized that a reduction in available farm land or an increase in land purchased for consumption will have a positive effect on land values.

Ease of Financing. At present farm land prices, most transfers are financed through seller contracts or through other forms of credit financing. The interest rate paid has a tremendous effect on total interest paid through the term of the loan (Plaxico and Kletke, 1978). The terms and duration of the loan exert similar pressure on the borrower due to their impact on the net present value of the purchase. In the aggregate most differences in terms and duration may be washed out. However, the interest rate prevailing at the time of purchase must exert an influence on the borrower. Therefore, it is hypothesized that the rate of interest for farm real estate mortgages exerts a negative influence on land values. The higher the interest rate, the lower the price buyers are willing to pay for the land.

The mortgage interest rate is often suggested as one of the factors

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[3]Farm land can be "created" through clearing, draining or irrigating non-productive land.

determining the appropriate rate to use in discounting future returns in the classical capitalization formula discussed earlier. An increase in the interest rate would, because of the algebraic position of the discount rate, reduce the value of land if net returns remained constant. Thus the financing variable has a direct effect in valuing farm land.

Other Factors Not Directly Related to Income

Alternative Investment Returns. Farm land has become an important part of the investment portfolios for some investors, particularly in the last five years. Of course, not all these investors are farmers or even knowledgeable agribusinessmen. It seems probable that they consider other investment opportunities and the associated rate of return of these investments before investing in farm land. Thus, it is hypothesized that the rate of return on alternative investments affects demand for farm land as an investment through its impact on the capitalization rate.

Alternative investments often have different nominal return rates and liquidity than farm real estate. Those farm land buyers who are using the land primarily as an investment may require the return to be proportionately higher to compensate for the lack of liquidity associated with land ownership.

Past Capital Gains. Past capital gains or land price changes would seem to have an effect on future price changes or gains. For brevity, both capital gains and losses will be referred to as capital gains. Past positive changes in land price would have the theoretical effect of firming buyers expectations of future price changes. A

history of positive capital gains, even in the face of economic recession in other sectors of the economy, would have the effect of encouraging demand both for investment gains (realized by sale) and for building equity (wealth) if held for longer term. Just as in the case of income, one would expect capital gains to have an effect on farm land prices for more than one year since its effect is one of firming expectations. Thus it is hypothesized that past capital gains will affect farm land price changes and that the effect will be felt for several years.

Foreign Investor Demand. A relatively new element in the U.S. farm land market is the activity of foreign citizens. Several factors in the world economy may have contributed to increased foreign purchases of U.S. farm land. The full extent of foreign ownership of farm land can only be estimated. Latest estimates by the USDA suggest that not more than one percent of all U.S. farm land is owned by foreign interests.

Since 1973, Middle East oil-producing nations have accumulated billions of dollars in profits from oil sales. Many of these billions have been invested overseas in a variety of banking, corporate and financial investments. The extent of Middle East investment in American farm land is not known. However, funds from oil profits could conceivably be made available for purchases of farm land.

European investment in U.S. land may be more prevalent than oil trust investments. A primary reason for European interest is the devaluation of the American dollar against European and other currencies. Since 1970, for example, the Swiss franc has more than doubled in value against the U.S. dollar. Thus a choice parcel of Corn Belt land selling

for 3,000 American dollars would actually "cost" a Swiss investor less than 1,500 equivalent dollars in terms of 1970 francs. With similar-quality farm land selling for much more than 3,000 dollars per acre in Switzerland, American farm land is a bargain.

Another reason for European investment is the relative stability of the American government compared to some of the socialist-leaning governments in Europe. Investment in American farm land, a dependable store of value under a stable government, would protect the fortunes of wealthy Italians, for example, whose future government policies concerning private land ownership are uncertain.

Japanese investment in California farms may be prompted more by the difference in exchange rates than other reasons. The value of the yen has increased substantially relative to the dollar in recent years causing American farm land to be an attractive investment.

All of the factors which cause farm land to be a profitable investment to American buyers may be amplified for foreign buyers. Farm land at "bargain" prices under a stable government offers an excellent investment for foreign buyers. Foreign demand would tend to increase total demand for U.S. farm land and thus would be a positive force on land prices.

Alternative Use of Labor. Farm land which is owned by the farm operator provides an opportunity to utilize operator and family labor. The rational operator will compare the rate of return he receives for family labor with the return or wages that could be received by utilizing the labor in a different endeavor. Therefore, when the return from an alternative activity exceeds the labor return from farming (adjusted, perhaps, for noneconomic and social benefits), the rational

operator may seek to engage in the alternate activity. However, availability of alternate opportunities is not constant over time. If the farm family's labor is under-utilized, they may either enter the new activity, if it is available, or seek to more fully utilize their labor in farming.

If alternative employment is readily available, the operator may sell out completely or reduce his present level of activity to engage in alternative employment. If employment is not readily available, he may seek to more fully utilize family labor by expanding the operation through acquisition of more land. This expansion pressure will increase demand for land.

On the national level, opportunities for alternative employment of labor would seem to have a negative effect on land prices. If opportunities are readily available, negative pressure should be felt on land prices as operators move to the opportunities. If alternative employment is not readily available or even difficult to find, the resulting expansion pressure should exert a positive effect on land values. It must also be recognized that many farm operators are strongly motivated to buy additional land in order to build a business large enough to retain family members in the family farm business.

Inflationary Expectations. Inflationary expectations would seem to affect land values in a positive manner. With all factors other than the general price level constant, a farm land buyer has apparently been willing to pay progressively higher prices for land as the general price level has risen. In fact, farm land has been an exceptional inflation hedge leading one to believe that inflationary expectations may have been bid into land values with land being considered to be a

dependable store of value.

With the erosion of true returns (above the rate of inflation) during times of large increases in the general price level, many investors shift funds to real assets. These assets have traditionally maintained their value in real terms and have presented capital gains for those investors owning the assets.

Summary

We have specified that changes in farm land prices are due to factors relating to demand for farm land. The working hypothesis is that changes in these factors cause changes in the value of farm land from year to year. The economic relationship, positive or negative, has been specified for each variable or factor. Admittedly, many other forces affect the value of farm land particularly when referring to forces involved in a single transfer or forces within a small geographical area. However, the intent here is to specify, on a national level, the identifiable forces which affect published estimates of farm land prices from year to year.

CHAPTER III

STATISTICAL MODEL FORMULATION

Statistical Model

The economic relationships which are hypothesized to determine farm land prices are presented in Chapter II. In order to test the validity of the stated hypotheses and to quantify the parameters, the economic relationships must be expressed in a format which allows statistical measurement. This statistical formulation should, as closely as possible, represent the nature of the economic relationships.

The general form of the statistical model to be estimated is:

$$Y=fn(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12})$$

where

Y=Index of Farm Real Estate Prices (1967=100)

X_1=Inflationary Expectations

X_2=Total rate of return on an unmanaged common stock fund

X_3=Productivity

X_4=Government program contribution to net income from farming

X_5=Taxes

X_6=Demand for food and fiber

X_7=Ease of financing

X_8=Urbanization

X_9=Alternative employment opportunities

X_{10}=Consolidation

X_{11}=Net income from farming

X_{12}=Past capital gains

The model is a single equation one with emphasis on prediction as opposed to parameter estimation. The simultaneous system method assumes that both a supply curve and a demand curve exist for farm land at a point in time. Thus factors may be specified which affect the supply of land as well as factors which affect demand. However, it is quite difficult to separate demand factors from supply factors as these concern farm land values. Thus an identification problem exists when one uses a method which requires specification of both supply and demand.

The basis for single equation estimation of farm land values is the assumption that supply is perfectly inelastic during a period of time. While this assumption may not be valid on a national or even regional basis, our earlier discussion of the land market suggests that there is no national or regional market. The market is a local one characterized by a small number of potential buyers and sellers. This environment allows accurate single equation estimation to be accomplished. We assume, therefore, that supply of farm land available for transfer is fixed within each year. Therefore we can estimate the appropriate land price by specifying demand factors and establishing the equilibrium price for each year. The estimated value will be the average of all markets' demand-supply equilibrium prices.

Representative Variables

Dependent Variable

The dependent variable for the statistical model is the Index of

Farm Real Estate Prices.

Explanatory Variables

The statistical model specified earlier in this Chapter relates the economic variables proposed in Chapter II to the dependent variable in a general way. In this portion of Chapter III, the economic variables will be specified as to a representative data series. The source of the series will be discussed and its limitations for use in the model.

Inflationary Expectations - X_1. It was suggested that inflation in the economy causes investors to adjust investment portfolios to include real assets, a traditional store of value. A broad measure of general price level in our economy is the Consumer Price Index. This Index is developed and published by the Bureau of Labor Statistics. The CPI is used in the model both as a deflator for other variables which should be expressed in real terms and as an explanatory variable representing inflationary trend. As an explanatory variable, the Consumer Price Index is expected to exert a positive influence on farm land values. Thus the coefficient is expected to have a positive sign.

Rate of Return on Alternative Investments - X_2. Farm land provides two types of returns from investment in it. First farm land provides direct income to the owner. This income is either in the form of rents to the landlord or as a residual return to operators owning their land. Second, the ownership of the land, a price-sensitive asset, allows the title holder the right to the gains (or losses) associated with changes either in the selling price (in case of sale) or in the market

value. A class of asset capable of providing similar categories of returns but perhaps with a greater degree of liquidity is common stock. Common stocks provide current income in the form of dividends to stockholders. Since common stocks are traded continuously their value is known at all times. Therefore, as a proxy measure of comparable rate of return on alternative investment opportunities, a derived percentage rate of return which results from the following equation will be used to represent the rate of return on alternative investments.

$$ALTRET = (SPSA_t - SPSA_{t-1})/SPSA_{t-1} * 100 + SDIV$$

Where ALTRET = rate of return on alternative investments

SPSA = Standard and Poor's 500 stock average

and SDIV = average dividend return on common stock (%).

The result of the equation gives both the percentage change in stock values (capital gains or losses) plus the average dividend as a percentage of market value. This gives us an estimate of the total rate of return from stock investments for a period beginning January 1 of each calendar year and ending December 31. The Standard and Poor's 500 Stock average is published at the close of every day of trade on the New York Stock Exchange. The average dividend on common stocks is published monthly in the Federal Reserve Bulletin.

An increase in the common stock return is expected to direct funds away from agricultural land ownership. The decrease in demand for farm land would result in a decrease in land prices if other factors remain unchaged. Therefore a negative sign is expected for the coefficient of the alternative rate of return variable.

Resource Productivity - X_3. Several data series are available to represent productivity increases in agriculture. The USDA provides

indexes of farm output per hour of farm work, crop production per acre, and output per unit of input. In this study the broadest series, that of output per unit of input, is used. This series accounts for all inputs into the production of agricultural products and compares these inputs to the level of output achieved, reflecting the overall efficiency of the agricultural sector.

Productivity increases are hypothesized to cause an increase in the demand for farm land in order to take advantage of scale economies. This demand increase is expected to have a positive effect on farm land prices. The coefficient for the variable should have a positive sign.

Government Payments - X_4. The role of government payments, as suggested by Herdt and Cochrane, is to increase farm land values during periods of technological advance. In general, prices supported above competitive equilibrium cause higher than normal profits which quickly become capitalized into land values. Also, government payments may tend to reduce uncertainty. To show the effect of government payments on land values, a proxy variable is constructed expressing the ratio of real government payments (expressed in 1967 dollars) to net income from farming (excluding government payments and expressed in 1967 dollars). An increase in this ratio is expected to exert a positive influence on land values.

Taxes - X_5. Real estate taxes are a fixed cost to land owners and are expected to represent a negative force on land values. Two data series seem appropriate for use as this variable. Taxes per $100 value and taxes per acre are both published by the USDA to represent tax levels. Taxes per acre would seem more appropriate since the dependent

variable is on a per-acre basis. Thus, taxes per acre will be used to represent the effect of tax liabilities of farm land values. The negative force on land values would be expected to produce a negative sign on the coefficient associated with the tax data series.

Demand for Food and Fiber - X_6. The effect through time of changes in the U.S. population on farm land values is quite difficult to quantify. The food and fiber consumption curve, with respect to population, is hypothesized to be linear. Thus, rather than attempt to quantify demand at different ages, we hypothesize here that demand for food and fiber is bid into land values at the rate that U.S. population grows.

A series representing demand for food and fiber taken as a whole could not be measured and is not available. However, because the demand for food in total in the U.S. is quite price and income inelastic, we must express the primary demand with the use of a proxy variable, population. The U.S. population is estimated annually and measured at each census. Therefore the series is readily available and will be used to represent demand for food and fiber from the agricultural sector. An increase in this demand is expected to be transferred to farm land demand. Thus an increase in demand for farm products is expected to result in higher prices for farm land. The coefficient is expected to carry a positive sign. A major problem with this variable is that export demand is not considered, or is assumed to increase at the same rate as U.S. demand.

Ease of Financing - X_7. In the most general sense, the ease of financing a farm land purchase can be measured by the cost of the funds, the interest rate. When interest rates rise in response to

diminished availability of funds, financing farm land purchases becomes more difficult. The U.S. Department of Agriculture publishes a series of annual average mortgage interest rates which will be used to reflect ease of financing debt purchases of land. An increase in the interest rate, indicating more difficult financing terms is expected to exert a negative influence on land values. The coefficient is expected, therefore, to carry a negative sign, consistent with its possible use in the income capitalization formula discussed earlier.

Urbanization - X_8. Off farm demand for land for uses other than agriculture was suggested as a strong force in the land market near urban areas. This variable is exceptionally difficult to represent because there are no annual data series which embody the proper concept. In each Census, however, an estimate is made of the percentage of total U.S. land area covered by the Standard Metropolitan Statistical Areas (SMSA). A series can be built from these spot estimates to represent off farm demand for land for urbanization. The series is built by interpolating between the spot estimates for the years between Census estimates. The trend line from 1970-75 was extended to predict values for 1976 and 1977. This series will represent off farm demand for land.

Bidding for farm land near growing metropolitan areas to use in urban development is expected to increase demand and, subsequently, price dramatically. The coefficient for this variable is therefore expected to be positive.

Employment Opportunities - X_9. In searching for profitable uses for family labor, the rational farm operator must compare the returns

he could realize by employment elsewhere against the returns he could attain by expanding his present operation through the purchase of more land. On a local basis this comparison can be made rather readily. On a national basis this determination is not so easily done. A measure of employment opportunities available on the national level is the unemployment rate. The best series to represent opportunities for typical farm labor would be the unemployment rate for the male population over 20 years of age. However the series is not available for the full period of estimation. Therefore the unemployment rate for all workers has been selected to represent off farm employment opportunities.

A decrease in the availability of off farm labor opportunities is expected to exert a positive influence on land values. Therefore, the expected sign for the variable's coefficient is positive.

Consolidation - X_{10}. Although consolidation pressure, or farm enlargement pressure, is tied closely to technological advance, the concept has effects in and of itself on land values. Not only do larger farms spread fixed costs to a greater degree, the larger cash flows usually generated by these farms can assist in purchases of additional plots. The U.S. Department of Agriculture series reflecting average farm size will be used to represent the effect of farm consolidation. The pressure of greater bidding potential of larger farms is expected to increase demand for farm land and thus the price. The coefficient for the variable is expected to show a positive sign.

Net Income - X_{11}. The effect of net income from farm commodity production is expected to be somewhat different than the effect of the

above variables. Farm income, the theoretical basis for land value, is expected to have an effect on land price not only in the present period but also in future periods. Said another way, the present farm land price is affected by present farm income as well as by incomes in past time periods. If the concept is extended to infinity in either direction, the result is the theoretical formula where annual returns are capitalized by an appropriate discount rate to determine a value for the land. This model, however, will explore the effect of a limited history of incomes on farm land prices.

The allocation of income to provide an estimate of returns to all production activities and assets has always been a difficult one. Net income from farming, as published by the Department of Agriculture, is computed as the realized gross income from farming less production costs.[1] Thus the return called net income to farm operators is, in fact, a return to unpaid family labor, operator labor and management, owned land, and risk. Allocation of this income to the various factors of production has been debated in the past and the debate is not settled. Also, the absolute amount of family and operator labor has been declining over time leaving a question as to how much could accurately be allocated to these resources. Thus, rather than arbitrarily assign a return to land, the listed series will be used as the representative variable for return to land.

Both the sum of the lag coefficients and each individual coefficient are expected to show positive signs. This means that an increase in net farm income will increase land values both in the present period as well

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[1]Realized gross income from farming = cash receipts from marketings + government payments + non-money and other farm income furnished by farms.

as in several subsequent periods.

Expected Capital Gains - X_{12}. For both the off farm investor and the owner-operator who is investing in farm land, the expectation of price increases in farm land may play a prominent role in the decision process. As pointed out earlier, returns (in the form of net return to farm land when capitalized into land price by the normal appraisal formula) do not appear to justify current land prices when using traditional discount rates. However, a capital-budgeting approach which includes values for land price increases and a "salvage" value at the end of the planning horizon discounted to the present time may present a different picture of the investment. It seems logical that past changes in price level, discounted for uncertainty, would be the best indicator of future changes. As in the case of income, there would seem to be a lagged nature to the effect of past price changes. A history of consistent changes in price level would firm the confidence of bidders that these changes will continue to occur in the future.

This study will use changes in the Farm Real Estate Price Index, that is, the first difference of the dependent variable, as the explanatory variable embodying capital gains expectations. The use of this series is more as an adequate representation of the variable than as an explicit one. Neither new capital improvements to farm real estate nor depreciation of past improvements are accounted for in the Index. However, it is hoped that, by aggregation, significant deviation from true price level changes will be reduced.

Again, both the sum of the lag coefficients and each individual coefficient are expected to have positive signs. Positive real capital

gains in the past year are expected to have a positive effect on this year's capital gain as well as for gains several years in the future.

Almon Polynomial Distributed Lag Procedure

Variables X_{11} and X_{12}, net income and past capital gains, are expected to affect land values for more than one period. In order to express variables X_{10} and X_{11} as having multiple-period effects, we must determine an appropriate lag structure for the model. Earlier research which has included variables from several past periods has usually been required to specify weights for these periods. Examples of these weighted periods are the geometric lag and a weighted average. In each case, the weights for each period are fixed and thus the coefficients estimated are for a given pattern of history. The Almon (1965) polynomial distributed lag model assumes that the lag weights (specified for other lags) can be determined by a continuous function. By evaluating this function for the appropriate points in time, the weights for each time period can be determined. This model allows great flexibility in determining weights for a lag structure.

To use the Almon polynomial distributed lag, one must determine several conditions prior to estimation. First, one must determine an appropriate time lag or number of periods during which the explanatory variable affects the dependent variable. This depends largely on prior knowledge of the problem and a feel for the length of time the explanatory variable affects the dependent variable. Second, the researcher must specify the degree of the polynomial which describes the function. Again, economic theory and a feel for the problem should assist in determining the proper degree. Last, one must specify either

a head, tail, or no restriction. A head restriction allows the researcher to specify that the current year value of the explanatory variable has no effect at all on the dependent variable. Tha tail restriction permits the same specification on the last period in the lag. The procedure can also be executed with complete flexibility, that is, no restriction at all. When no restriction is specified, the polynomial distributed lag procedure will fit the function to the data with no inhibition on coefficient values. A more complete description is available in the original Almon article and in explanatory volumes published subsequently (Almon 1965, Kmenta 1971, and Pindyek and Rubinfeld 1976).

In using the polynomial distributed procedure, the researcher may experiment with various lag periods, polynomial degrees and functional restrictions. However, economic theory should be followed even though high R^2 values may spuriously result from illogical specifications. Even with the high R^2, the equation may not predict well if the economic theory is not consistent or logical.

Summary

The economic variables have either been assigned data series to express their effects directly or data series which are proxy variables representing the hypothesized variables in the statistical formulation.

Variables which are expressed directly by data series are (with data series name in parentheses):

Inflationary expectations (Consumer Price Index)

Alternative rate of return (derived return series)

Productivity (output per unit of input series)

Taxes (real estate taxes per acre series)

Consolidation pressure (average size farm in the U.S.)

Net income (net income from farming series)

Capital gains expectations (past changes in the U.S. Index of Farm Real Estate Prices)

Both net income from farming and past capital gains are expressed in real terms (deflated by the Consumer Price Index).

Variables which require proxy variables because of an inability to accurately express their effects directly are (with proxy series in parentheses:

Government contribution to farm income (ratio of real government payments to real net income for each year)

Demand for food and fiber (U.S. population series)

Financing ease (average annual mortgage rate)

Urbanization (constructed series of SMSA area)

Alternative labor opportunities (U.S. unemployment rate)

No explicit or proxy variables are included in the model expressing the effects of foreign investment and reduction in land available for farming. The urbanization variable may include the effects of the latter concept. Information concerning foreign farm land investment is quite sketchy and incomplete. More information regarding frequency and extent of foreign ownership of farm land is needed before the concept can be included in the analysis. Current government studies and investigation may yield more data concerning the extent of foreign farm land ownership in the U.S. When these data become available, more explicit use can be made of the economic variable.

CHAPTER IV

EMPIRICAL RESULTS

Empirical Results

Table I presents the results of estimating alternative specifications of the model. Each specification was fitted using ordinary least squares for all variables except net income and lagged capital gains. These variables were included in the model using the Almon polynomial distributed lag procedure to show more flexible multiple-period effects. Coefficients for the explanatory variables and their significance level are shown.

Equation (1) is the result of estimating the model with all hypothesized variables included. Only seven of the twenty estimated coefficients show statistical significance at the .05 level ($t \geq 2.07$). From past work, it has become clear that many of the data series hypothesized to affect farm land prices are highly correlated. When independent variables are highly correlated, statistical problems of multicollinearity occur. Symptoms of these problems are (1) a lack of precision in the coefficients (low t values) and (2) uncertainty as to which variables should remain in the equation. These symptoms are certainly present in the first equation of results implying some degree of multicollinearity.

To determine which of the explanatory variables are highly correlated, refer to Table II. Shown on Table II six selected

TABLE I

EMPIRICAL RESULTS, ESTIMATED INDEX OF FARM REAL ESTATE PRICES[1]

PART I

EQ	C	GOVCON	POP	INTRT	URBAN	OPIP	UNEMP	ASIZE	CPI	ALTRET	TAXES
(1)	-85	21.58*	1.31*	-13.20*	13.04**	-.20	-.50	-.40	-.04	-.009	3.48
(2)	-86	23.9 *	1.20*	-12.06*	13.16**	-.19	-.47	-.33	-.002	.006	
(3)	-87	23.9**	1.20*	-12.06*	13.24**	-.19	-.47	-.33	-.008		
(4)	-63	17.1**	.83	- 9.80*	11.90**	-.25	-.33	-.17			
(5)	-29	13.60*	.35**	-11.10**	12.04**	-.21	-.17				
(6)	-29	14.60**	.37**	-12.90**	12.40**	-.21					
(7)	-25	14.50**	.27**	-13.6**	12.40**						

TABLE I (Continued)

	PART II											
	RINC						RCG					
EQ	1	2	3	4	5	6	1	2	3	4	5	F
(1)	-.16	.028	.14	.175	.14		.68**	.49**	.26*	-.02	-.34	649.2
(2)	-.13	.03	.14	.18	.15		.65**	.47**	.26*	-.01	-.31	720.2
(3)	-.13	.03	.14	.18*	.16		.64**	.46**	.24*	-.01	-.31	806.5
(4)	-.04	.05	.11	.13	.10	.04	.78**	.46**	.30*	.30		847.0
(5)	-.05	.077	.15*	.17**	.13**	.05	.78**	.43**	.28**	.32		917.3
(6)	.013	.11**	.16*	.16**	.12**	.03	.79**	.43**	.28**	.34*		1016.9
(7)	-.02	.09*	.16*	.18**	.14**	.06	.80**	.43**	.25*	.24		1069.4

[1]Estimated with annual data from 1940 to 1977. Variables defined in text.

* - significant at the .05 level ** - significant at the .01 level or greater

TABLE II

CORRELATION MATRIX OF SELECTED INDEPENDENT VARIABLES

	TAXES	URBAN	CIP	OPIP	POP	ASIZE
TAXES	1.00	.987	.972	.968	.974	.947
URBAN		1.00	.967	.939	.906	.907
CPI			1.00	.929	.911	.901
OPIP				1.00	.984	.984
POP					1.00	.999
ASIZE						1.00

TAXES = Average farm real estate tax per acre

URBAN = Percent of total U.S. land area within Standard Metropolitan Statistical Areas

OPIP = Index of output per unit of input for agriculture

POP = Population of the United States

ASIZE = Average size farm in the United States

CPI = Consumer Price Index

explanatory variables which are highly correlated with correlation coefficients ranging from .901 between average size farm and consumer price index to .999 between average farm size and U.S. population.

One practical way to deal with highly collinear explanatory variables is to allow one variable to be represented in the equation by another variable with which it is highly correlated. While this practice is not theoretically sound because of possible specification bias, it is often used because it allows some coefficients to be interpreted rigorously while causing a more vague interpretation of the proxy variable's coefficient since it combines the effect of several variables. The procedure used below is to eliminate variables whose coefficient signs are illogical and whose coefficients are not statistically significant. This procedure is followed step by step, eliminating one variable at a time. The variables which are most collinear are addressed first with the objective of consolidating the effects of eliminated variables into the proxy variable.

Equations (2) through (6) show the results of step by step elimination or consolidation of highly collinear and other varibles. A 0.05 percent decrease in R^2 is experienced but the F statistic increases from 649.0 to 1069.4. There is general improvement in the statistical significance of coefficients, with some coefficients changing a great deal and others remaining rather stable. The coefficients in the distributed lag structure stabilize during the consolidation steps, gaining in statistical significance. The coefficient for the population variable is relatively stable until average size farm and Consumer Price Index are deleted from the consolidation of its effect with the average farm size effect. The

very close correlation between these three variables (over .90) is the probable cause for the changes.

Equation (4) was estimated after two changes were made in the formulation. First, the Consumer Price Index was deleted from the model because its coefficient had an illogical sign and because the t value was extremely low. Also, this variable introduces some statistical problems because several of the variables have been deflated, prior to estimation, by the Consumer Price Index. Second, the lag periods for the lagged variables were changed. As was suggested earlier, a trial and error procedure is used to determine the "best" fit of the polynomial distributed lags. An increase of one period for lagged income improved its fit by reducing the magnitude of the coefficient whose sign is not consistent with economic theory. A decrease of one period for lagged capital gains accomplished the same effect, that of improving the fit.

It seems logical that dollar income from any one year may have a longer-lasting effect on buyer expectations than past capital gains, which may or may not be realized as income. In the case of established operators, past capital gains are probably not realized directly and thus have a shorter-range effect on their expectations.

The effects of variables dropped because of low t values and high collinearity with other explanatory variables is thought to be "picked up" by variables left in the equation. The effects, then, are thought to be expressed in the model despite the fact that the variables were left out. The proxy variable assumed the effect, expressed by its coefficient. Thus, although the model appears to predict well, the structural parameters are not valid.

The results of the final model formulation are restated in Table III along with the associated test statistics. The first row contains coefficients for all unlagged variables and the sum of the lag coefficients (total effect) of the lagged variables. The second row shows the coefficients for each year of the lag structure for real income. The third row shows the coefficients for periods in the structure of lagged capital gains. The last row shows the R^2, adjusted R^2, standard error of regression, Durbin-Watson d statistic and the F test. The d statistic indicates that no autocorrelation is present in the model. The F test is highly significant at greater than the .01 level.

The multiple coefficient of variation (R^2) is very high for this model which predicts actual from land Index extremely accurately. Figure 4 depicts the model's predicted Index and the actual real Index during the time period 1940-1977. A one-point change in the Index is worth $1.68 in true land price since the average value per acre of U.S. farm land was $1.68 for the base year (1967) of the Index.

The independent variables which are not lagged show signs of associated coefficients which are consistent with economic theory as we reviewed in Chapter II. We expected government payments, demand for food, farm income, past capital gains, and urbanization to exert positive pressure on farm land values. It was expected that mortgage interest rate would exert a negative influence on land values in keeping with income capitalization theory. All these hypotheses are supported by the empirical results.

The pattern followed by farm income and past capital gains deserves some attention. First, capital gains follows a declining pattern, indicating that capital gains nearest the present time have the greatest

TABLE III

EMPIRICAL RESULTS, FINAL MODEL

GOVCON	POP	INTRT	URBAN	RINC	RGG
14.50	0.27	-13.60	12.4	.613	1.73
(3.05)	(7.40)	(-4.69)	(11.60)	(4.47)	(6.11)

$RINC_t$	$RINC_{t-1}$	$RINC_{t-2}$	$RINC_{t-3}$	$RINC_{t-4}$	$RINC_{t-5}$
-.02	.09	.16	.18	.14	.06
(-.23)	(2.53)	(2.65)	(3.03)	(3.85)	(.61)

	RCG_t	RCG_{t-1}	RCG_{t-2}	RCG_{t-3}	
	.80	.43	.25	.24	
	(6.63)	(4.86)	(2.70)	(1.69)	

	R^2	$\bar{R}^2$	S.E.	D-W	F
	99.75	99.61	1.69	2.13	1069.4

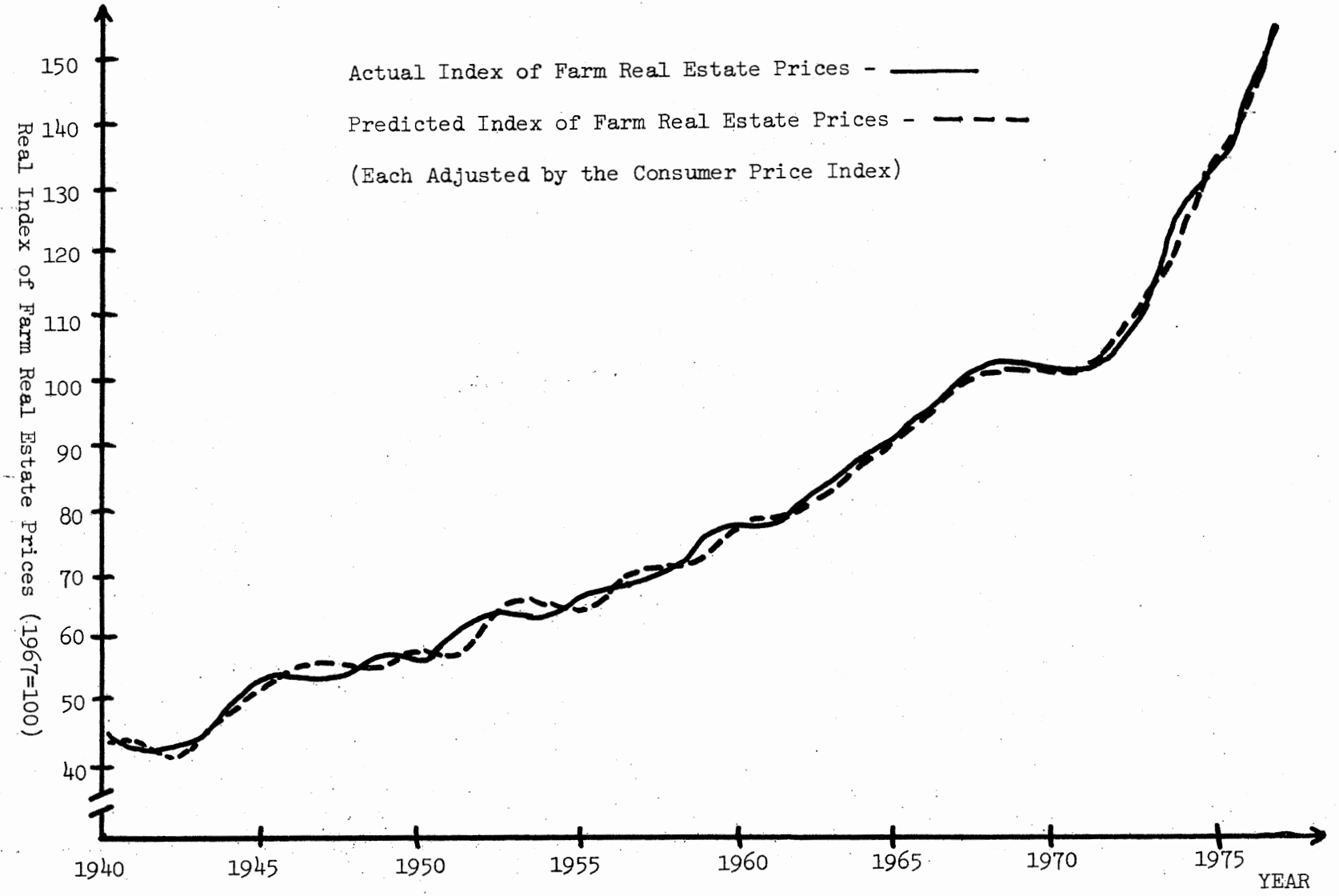

Figure 4. Actual vs. Predicted Real Index of Farm Real Estate Prices (1967=100)

effect on gains during the present time periods. Gains observed during periods further into the past exert substantially less positive influence. The pattern followed by farm income is more ambiguous. The lag coefficients indicate that incomes observed in the second, third, and fourth years prior to the present period exert the most pressure on present farm land values. While agreeing, in general, with the results of Hauschen, the lag structure does not fully support economic theory. Perhaps the sensitivity of the lag procedure combined with the assumptions or conditions which must be determined prior to estimation, cause the effect to be postponed. The results show that, in general, past incomes gain in importance in determining present land values and then decrease in importance as time passes.

Elasticities

It is more useful for analytical purposes to convert the model's coefficients to elasticities which can be used to estimate effects of changes in the independent variable on the dependent variable. The general form of the elasticity calculation is:

$$E = \frac{dy}{dx} \cdot \frac{x}{y}$$

where $\frac{dy}{dx}$ is the regression coefficient and x and y are particular values for the explanatory and dependent variables.

Table IV depicts the elasticities calculated by the formula above using both full-period mean values and recent-period (1974-1977) values. By utilizing this method we may receive a clearer view of changes in the effects of important variables determining land values, especially since 1974.

In general it appears that the elasticities for urbanization,

TABLE IV

ELASTICITIES, CALCULATED AT 1940-1977 MEAN VALUES

AND 1974-1977 MEAN VALUES

	Using 1940-1977 mean values	Using 1974-1977 mean values
URBAN	1.43	1.29
POP	.585	.410
GOVCON	.022	.005
INTRT	-.89	-.687
REAL INCOME		
Period t	-.004	-.002
Period t-1	.017	.009
Period t-2	.029	.015
Period t-3	.032	.017
Period t-4	.026	.014
Period t-5	.012	.006
REAL PAST CAPITAL GAINS		
Period t	.026	.052
Period t-1	.014	.029
Period t-2	.008	.016
Period t-3	.008	.016

population and interest rate have not changed a great deal using the two mean value sets. However, the effect of the government's contribution to income reduced to one-fourth its full-period value. Elasticities for real farm income nearly halved when calculated at 1974-1977 values while elasticity for past capital gains doubled when calculated at recent period values.

Using elasticities calculated with the 1974-1977 mean values, the following interpretations result. For the unlagged variables, a 10 percent increase in the urbanization variable would result in a 12.9 percent increase in the real Index. A 10 percent increase in U.S. population would cause a 6.8 percent increase in land values. And finally, a 10 percent increase in the government's contribution to real income would raise farm land values .05 percent. It seems apparent that, of these single period variables, urbanization of farm land exerts the greatest effect on farm values.

The variables in the polynomial lag have multiple effects. For example, a ten percent increase in real net farm income would have a negligible effect during that year but would increase the real Index .09, .15, .17, .14, and .06 percent respectively, the next five years. The total effect of that one-time, ten-percent income increase would be .58 percent. These effects are cumulative. Subsequent income increases would add to the positive effect of past incomes increasing the total effect. Again, farm land values appear to be less sensitive to real income changes in more recent times than has historically been so. Elasticities have halved in value in recent times.

On the other hand, elasticities for past capital gains have generally doubled in recent years. A ten percent increase in real

capital gains during one time period results in .5, .3, .16, and .16 percent increases, respectively, in the real Index during the four subsequent years. The total effect, over four time periods, of this ten percent increase in capital gains is an increase in the real Index amounting to 1.12 percent.

Elasticity analysis allows inference concerning response to changes in explanatory variables by the dependent variable. Of the variables in the final model formulation, only net income from farming and past capital gains are capable of large percentage changes during any one year. The urbanization variable was constructed to show a constant, slow rate of change. In the same manner, U.S. population and interest rate change very slowly. The government contribution ratio may change rather quickly but its elasticity is very low.

Net farm income since it is a function of many uncontrollable variables such as world weather and political action, can vary widely from year to year. Because net farm income is so variable, it seems plausible to suggest that farm land values are more sensitive to changes in net farm income than to any other factors included in this study. Farm land values are also quite sensitive to past capital gains, especially during more recent times.

CHAPTER V

SUMMARY, IMPLICATIONS AND CONCLUSIONS

Summary

The average value of an acre of farm land in the United States has more than doubled since March 1, 1972. Measured in terms of total dollars, farm land increased in value from 241 billion dollars in 1972 to almost 550 billion in 1978. Land owners' equity has increased by more than 273 billion dollars during the same time period. The changes in value and equity have affected the very foundations of commercial agriculture in the United States. Not only are farmers affected by these changes but also agricultural lenders, foreign buyers, and the public in general. Understanding the basic factors causing these large increases is very important as the future of commercial agriculture and the family farm is tied closely to them.

In order to more fully understand the changes which have occurred in farm land values in the past, an economic model was formulated wherein many factors which were hypothesized to affect land values were included. The basis for each of the factors was examined and a data series selected to represent, as closely as possible, the effect of the factor on farmland values.

In order to test the economic formulation a statistical relationship was proposed which allowed expression of the economic factors in an econometric equation which would be estimated empirically and tested

for logical and significance. The nature of the relationship was defined for each factor as well as the expected coefficient sign. All of the factors were hypothesized to have a linear effect on the dependent variable except net farm income and lagged capital gains (both expressed in real terms). These variables were hypothesized to have effects over several periods. Expression of the multiple-period effect was accomplished by the use of Almon's polynomial distributed lag procedure.

The results of estimating the full statistical model were mixed. Only seven of the 21 explanatory variables had significant coefficients and over half of the signs were illogical from an economic point of view. The primary cause of this form of ambiguity in the results was multicollinearity among the explanatory variables. The correlation matrix of selected explanatory variables showed many correlation coefficients above .90 and one as high as .999. The high intercorrelation present caused low t values, high variance and doubt as to which variables truly affected farm land values.

A practical solution to the problem was to reduce the size of the model, eliminating explicitly those variables which were known to have high correlation coefficients with more stable and significant variables which were left in the equation. Thus the remaining variables expressed not only their own effects but, to some extent, the effects of variables dropped from the model. The model was reduced until all independent variables other than some coefficients for periods of real farm incomes and past capital gains coefficients which were statistically significant. One coefficient for net farm income carried a sign not consistent with economic theory but was not statistically significant.

Variables which seemed to affect farm land values most were net farm income, past capital gains, mortgage interest rate, nonfarm demand for land for urbanization purposes, demand for food and fiber by the consumer and government payments.

From the estimated coefficients elasticities were calculated. These values are useful in evaluating the relative effects of explanatory variables on farm land price changes. Because annual changes in taxes, interest rates and population are relatively small, net farm income, nonfarm demand for land and past capital gains seem to exert the greatest pressure upon land prices, particularly in the last five years.

The lagged effect of farm income and past capital gains on land values probably cause a hindrance to downward adjustment of land values which would be a logical result of a poor income year. The effects of a high capital gain year are felt most significantly during the first and second years after the observation year. The effects of a high income year are felt most significantly in the second, third, and fourth years following the observation year. A major downward re-adjustment in land values would occur only with two or three very poor years, a situation which government policymakers have prevented in past years. Because the government's contribution to income has a significant effect in the model, perhaps the major effect of government support is to prevent downward adjustments. Thus government support is an important factor particularly during low commodity price periods when farm land prices would logically be expected to decline.

Urbanization also had a significant effect on farmland prices. The demand for land, including farm land, for urban sprawl has effects on land values quite removed from the primary urban area. Urban sprawl

seems an irreversible process suggesting that this effect will continue to play an important role in farm land pricing.

Implications

The results of this study suggest that farm land price changes, in real terms, are most sensitive to changes in real net income from farming, past capital gains and urbanization, demand for farm land for urban uses. Other factors such as mortgage interest rate, basic demand for food and fiber and government payments also have significant effects on land values.

For the individual farm land owner, these results indicate that the value of the land he owns is affected most by the land's ability to produce income, as well as its desirability for annexation within an urban or semi-urban area. The rate at which general farm land prices are escalating in the area, past capital changes also dictate the rate of change in the value of his land.

The results also indicate to farm policymakers that actions which significantly affect farm income may have the most effect on farm land prices. Whether caused by direct payments under existing programs or by actions favorable to higher free market prices, the effects will be felt for a substantial length of time thereafter.

Because of the amount of correlation between several of the explanatory variables, some of the dropped variables' effects are probably expressed in the model through other variables. Farm enlargement pressure, a prominent variable in previous models, is not shown explicitly in this model but is probably expressing its effect in the population series with which it is highly correlated ($r=.999$).

In a similar manner, resource productivity and inflationary expectations are probably expressed by the population series or even the urbanization series. The hypothesis that land is treated by buyers and sellers as a store of value may be expressed most by the capital gains expectation lag variable. Past capital gains seem to firm the expectations of buyers that land value increases will continue.

The results of this study are in general agreement with various past studies. Net farm income is shown to affect land values in a way similar to the Hauschen model. However, this model went a step further to suggest that past capital gains, a measure of expected future capital gains, also affected land values for several periods in the future. Capital gains expectations was a factor determined by Klinefelter, Duncan, Reynolds, and Timmons, and Tweeten and Nelson (Martin) to be important in determining land values. Urbanization, or nonfarm demand for land, was mentioned by Klinefelter indirectly, and Tweeten and Nelson (Martin) and Hauschen directly. Again, the results of this model are consistent with those of similar past research even though the approach may have been different.

The econometric model proposed and estimated in this study predicted farm land values, expressed by the Index of Farm Real Estate Prices adjusted for inflation, quite accurately. Nearly all the variation in land values observed for the 38-year period was accounted for by the formulation. Although the final model had significant coefficients and logical signs, the effects of many seemingly relevant variables were either lost or confused with other variables. Thus the derived elasticities must be considered in that context. As long as the trends in the explanatory variables continue, the model will probably continue

to predict value changes quite well. The model seems more suitable for prediction of change than for accounting for causes of these changes.

Because of the inherent inability to achieve parameter accuracy with single equation estimation, it is suggested that further research in the area of farm land values be conducted with regard to structural relationships which exist. This, of course, implies some sort of simultaneous or recursive system of equations expressing both supply of and demand for farm land. The model in this study assumed a fixed quantity of land available for transfer during each time period. This is perhaps too simplified. A study of factors affecting supply of farm land would be constructive. This area seems relatively uncharted and further study could yield assistance in more fully determining the structure of the farm real estate market.

Conclusions

The results of this study suggest that net farm income, urbanization of farm land, capital gains expectations, mortgage interest rate, government payments and basic demand for food and fiber have been the important factors determining farm land values since 1940. An excessive amount of correlation between explanatory variables prevented explicit statements about some factors which seem important but which the model did not show. It is suggested that future research employ a simultaneous system of equations in order to achieve greater accuracy of coefficients and resulting elasticities.

This study seems to indicate that, on a national level, farm land prices are based primarily on the income-generating ability of farm land as well as the possibility of use-intensification for tracts

located near urban areas. Changes in these factors will have a major effect on the movement of farm land prices in the future.

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APPENDIX

LIST OF DATA SERIES

YEAR	US INDEX	NETIFF	CPI	RCG	RINC
1940	19	4.5	42.0	0.6	8.9
1941	19	6.5	44.1	-0.4	13.5
1942	21	9.9	48.9	2.4	18.9
1943	23	11.7	51.8	-0.5	21.3
1944	26	11.7	52.7	3.1	20.7
1945	29	12.3	53.9	4.8	21.4
1946	32	15.1	58.5	4.3	24.5
1947	36	15.4	66.9	2.2	22.6
1948	39	17.7	72.1	-3.2	24.2
1949	41	12.8	71.4	-1.4	17.7
1950	40	13.6	72.1	-0.8	18.5
1951	46	15.9	77.8	7.8	20.1
1952	51	14.9	79.5	1.8	18.4
1953	52	13.0	80.1	-0.1	16.0
1954	51	12.4	80.5	-1.7	15.1
1955	53	11.3	80.2	2.2	13.8
1956	55	11.3	81.4	2.7	13.2
1957	58	11.1	84.3	2.7	12.0
1958	61	13.2	86.6	1.1	14.0
1959	66	10.7	87.3	3.9	11.5
1960	68	11.5	88.7	1.7	12.2
1961	69	12.0	89.6	-0.1	11.7
1962	73	12.1	90.6	3.7	11.4
1963	77	11.8	91.7	3.5	11.0
1964	82	10.5	92.9	4.4	9.0
1965	86	12.9	94.5	3.2	11.0
1966	93	14.0	97.2	5.8	11.0
1967	100	12.3	100.0	4.5	9.2
1968	107	12.3	104.2	4.1	8.5
1969	113	14.3	109.8	1.4	9.6
1970	117	14.1	116.3	-1.9	8.9
1971	122	14.6	121.3	-1.7	9.4
1972	132	18.6	125.3	3.9	11.6
1973	150	33.3	133.1	10.9	23.0
1974	187	26.1	147.7	20.8	17.3
1975	213	24.3	161.2	3.7	14.6
1976	242	20.0	170.5	5.9	11.3
1977	283	19.8	181.5	15.9	9.9

YEAR	URBAN	GOVCON	POP	ALTRET
1940	7.0	.19	132.1	-2.8
1941	7.0	.09	133.4	-4.0
1942	7.0	.07	134.9	-4.6
1943	7.0	.06	136.7	37.5
1944	7.0	.07	138.4	13.7
1945	7.0	.06	139.9	25.5
1946	7.0	.05	141.4	16.6
1947	7.0	.02	144.1	-6.4
1948	7.0	.01	146.6	8.0
1949	7.0	.01	149.2	4.8
1950	7.0	.02	152.3	27.1
1951	7.2	.02	154.9	27.6
1952	7.3	.02	157.6	15.7
1953	7.5	.02	160.2	6.6
1954	7.7	.02	163.0	25.0
1955	7.9	.02	165.9	40.6
1956	8.0	.05	168.9	19.1
1957	8.2	.10	172.0	-0.4
1958	8.4	.09	174.9	8.1
1959	8.5	.07	177.8	27.5
1960	8.7	.07	180.7	0.8
1961	8.9	.14	183.7	21.6
1962	9.2	.17	186.5	-2.5
1963	9.4	.17	189.2	15.3
1964	9.6	.26	191.9	19.4
1965	9.8	.24	194.3	11.4
1966	10.1	.31	196.6	0.1
1967	10.3	.33	198.7	11.0
1968	10.5	.39	200.7	10.5
1969	10.8	.36	202.7	2.3
1970	11.0	.36	204.9	-11.1
1971	11.6	.27	207.1	21.4
1972	12.3	.27	208.8	14.0
1973	12.9	.08	210.4	1.4
1974	13.6	.02	211.9	-18.5
1975	14.2	.03	213.6	8.4
1976	14.8	.04	215.1	22.1
1977	15.5	.10	216.8	0.9

YEAR	UNEMP	OPIP	INTRT	TAXES
1940	14.9	60	4.6	.39
1941	9.9	62	4.5	.39
1942	4.7	68	4.4	.38
1943	1.9	66	4.4	.38
1944	1.2	67	4.4	.40
1945	1.9	68	4.5	.44
1946	3.9	71	4.6	.49
1947	3.9	68	4.5	.57
1948	3.8	74	4.5	.62
1949	5.9	71	4.5	.66
1950	5.3	71	4.5	.69
1951	3.3	71	4.5	.73
1952	3.0	74	4.6	.76
1953	2.9	75	4.6	.79
1954	5.5	76	4.6	.82
1955	4.4	78	4.7	.88
1956	4.1	80	4.7	.92
1957	4.3	80	4.7	.99
1958	6.8	87	4.8	1.05
1959	5.5	87	4.9	1.13
1960	5.5	90	5.0	1.21
1961	6.7	91	5.1	1.28
1962	5.5	92	5.2	1.35
1963	5.7	96	5.3	1.40
1964	5.2	95	5.3	1.45
1965	4.2	100	5.4	1.53
1966	3.8	97	5.4	1.65
1967	3.8	100	5.4	1.76
1968	3.6	102	5.6	1.93
1969	3.5	103	5.7	2.11
1970	4.9	102	5.8	2.27
1971	5.9	111	6.0	2.40
1972	5.6	110	6.2	2.50
1973	4.9	111	6.4	2.56
1974	5.6	105	6.6	2.70
1975	8.5	115	7.3	2.92
1976	7.7	116	7.2	3.08
1977	7.0	119	7.0	3.26

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