Land prices: changes and variability: the effect on Iowa grain farms

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Land prices; changes and variability:
The effect on Iowa grain farms

by

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Signatures have been redacted for privacy
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CHAPTER 1. INTRODUCTION

Recent decreases in agricultural land prices and increases in farm failures have raised questions concerning the relationships between farmland prices, farm income, and survivability of farms (Iowa Land Value Survey, Scott, 1983; Castle and Hoch, 1982). Since the mid-1940s the rate of forced farm liquidations has increased; from 1949 to 1978 the farm bankruptcy rate increased nearly seven-fold. Although the number of forced liquidations has not increased as rapidly, due to the lower total number of farmers. However, these figures do not include voluntary liquidations due to financial pressures. Also, real net income per farm, while increasing some over the past 30 years, has shown an increase in annual variability (Blase and Hosemann, 1973). Farmers have also been increasing their leverage, reducing stocks of highly liquid interest bearing financial assets (Baker, 1984), and have been holding higher inventories. During the time from the Great Depression until the late 1970s, farmland prices increased regularly, even if there were fairly large variations in the amount of the annual increases. During the 1970s, land prices continued to increase while real farm income began to decrease. The land prices decreases of the early 1980s could be seen as a readjustment to bring land prices back into relationship with real farm income and with real interest rates.

The affect of macroeconomic forces on the price of farmland and other areas of agriculture has long been discounted under the view that agriculture was immune from the boom or bust cyclical patterns of the
rest of the economy. During the last 15 years, changes in the nonagri-
cultural sector of the economy have been atypical with respect to the
previous 15 years in their magnitude and frequency, especially with
regard to interest rates and inflation. Macroeconomic conditions of the
economy affect the availability of funds to farmers for borrowing, as
evidenced by the rise in agricultural loan interest rates in conjunction
with the rise in nonagricultural loan rates. Macroeconomic conditions
can also affect farmers' expectations about the future, which can
influence farmers' decisionmaking processes. For example, a recession in
the nonagricultural sector of the economy may cause farmers to have dif-
ferent expectations about future returns than if the nonagricultural
sector was in a boom period given the same conditions in the agricultural
sector.

Variability of Returns

Questions rarely examined are the effects of risk and uncertainty
in the form of variability of both earnings from the use of land and of
capital gains on land prices and the effectiveness of different expansion
and financial policies in dealing with these risks. Increases in the
variability of returns, even though expected returns are unchanged,
increase the riskiness of holding land and therefore, should have an
effect on land prices. Changes in the expected variability of future
land prices affect both expected capital gains and the ability of land to
be used as security for debt financing. For example, if the collateral
value of land is based on the lowest expected future value of land at
some probability level over the life of the loan, then given the same trend in land prices, an increase in land price variability could lower the effective collateral value of the land. This, in turn might affect the value of the land to the farmer.

Along with the question of what are the effects of these less than fully understood factors, arises the questions of how can farmers control the effects on their farms and what new management skills a farmer will need to possess in the future to deal with changes in farm financing.

If the variability in farm income observed in the last 15 years continues and economic conditions in both the U.S. and world remain volatile, then the late '80s and early '90s could become a period of variable land prices as well as variable farm income. The effect of land price variability on the survivability and potential for expansion of farms becomes of great interest to farmers, farm lenders, and those involved in farming at all levels.

Past examinations of land pricing have dealt primarily with the relationship of capital gains, current income, and such variables as size of operation, size of equipment used, land productivity, financial term available to borrower, age of operator, etc. to land prices (Doll et al., 1983). Many studies examined expansion of farm operations with the goal of maximizing either a stream of profits or the net worth of the farm over some planning horizon. Even though this has an implied relationship to the survivability of the operation, until recently survivability of the farm has not been a main focus and has rarely been specifically included when examining land pricing and expansion. Some earlier studies
have looked at survivability but mainly with respect to the production or financial risk involved in various parts of the operation such as in using debt as compared to equity financing or buying versus leasing assets.

With little apparent risk of downward land price movement based on past land price trends, the only major fear of farm failure has been from over-extending into debt to the point where one or two bad years in producing or marketing a crop would cause insolvency. Downward land price movement adds a new dimension beyond production and marketing risks. That risk comes from the threat of lower land prices undercutting the value of the asset base on which present debt is secured or upon which future debt financing was planned.

Farm Goals

When examining farm expansion, the question of what is the appropriate objective function arises. Previous studies have often either maximized the present value stream of future profits or the terminal net worth of the operation. Wise and Brannen (1983) and others have looked at the question of multiple objective functions and how they rank in order of importance to farmers. Nearly all studies have shown that the most important goal of farmers is to stay in business. Before the increased risk of farm failure observed in the last few years, the risk of farm failure from over-extending the debt situation of a farm was small due to the general upward trend in land prices and the resulting capital gains. The use of profit or net worth maximizing objective
functions for decision making, in situations with an underlying assumption of increasing land prices or at least no possibilities of land price decrease, may have provided realistic decision plans given the perceived lack of land price risk. However, recent changes in land prices and land price variability may make the use of the objective of maximizing profits or net worth less than optimal in reflecting how farmers make decisions under uncertainty unless these changes are included in the models.

There are several ways to add the goal of staying in business into a decision making model by using farmer imposed debt financing restrictions. One restriction would be to limit debt financing by only using a portion of the assets as collateral. In other words, the farmer when calculating a self-imposed debt limit would subtract the value of a base portion of the operation from the total value of the operation and calculate the desired maximum debt level from the remaining assets. A second type of restriction would be to use a desired maximum debt to asset ratio for the operation as a whole.

Statement of Purpose

The purpose of this study is to examine the recent phenomenon of decreases in the price of agricultural land, primarily focusing on Iowa farmland, and to evaluate the impact of this on farms. Four basic questions will be examined

1. What are the effects of land price variability on survivability and growth potential of farms?
2. What are the effects of different financial and expansion policies on survivability and growth of farms?

3. What is the effect of variability in land prices, income, general price levels, and interest rates on the ability of farmers to finance expansion, in part by examining under normal and worse case situations what levels of debt a farm can manage?

4. What have been the recent changes in land price trends and variability?

The issue of land pricing, both the theoretical and empirical aspects, is not the primary focus of this report. However, an attempt is made to identify factors which influence land prices that also affect other areas of interest to this report. For example, if interest rate variability affects both land prices and the availability of funds for investment by a farm firm, then examining the effect of a change in interest rate variability on survivability and expansion without considering the effects on land prices can lead to incorrect conclusions.

Concerning the farm model itself, the main emphasis is on the financial part of the model, an area often overly simplified in farm models. Here again, the problem of manageability comes into play. The vast number and types of sources of credit available to farmers, the large diversity in the availability of credit management policies for use by both lenders and farmers, the possibility of leasing or renting assets instead of purchasing them, and the effects of off-farm income on the
financial stability of the farm allows for almost an infinite number of financial management options available to farmers.

Farm Financing

Of key importance in this study, is how a farm finances new investments. There are two types of funds available for investment equity and debt. Equity financing is available based on the past and present returns of the farm. Debt financing relies upon expected future returns to assets. Debt financing creates a future obligation to repay the debt plus financing costs. Where the funds to meet these obligations are expected to be generated is important to the financial structure of the farm. Also important to the financial structure of the farm are the assets that are used as security or collateral for a loan. During the 1970s, many farmers were refinancing land to take advantage of unrealized capital gains to make downpayments on new land purchases. This places both the old and the new land as security against the loan, yet if the financing costs before the new debt are at or approaching the limit of what the old land could be expected to carry, then the entire financing costs of the new debt may be expected to be met by returns from the new land. The problem arises when future returns do not meet expectations. Then, profitable assets such as the old land at its old financing costs, may have to be liquidated to meet debt obligations on new nonprofitable land at its higher financing cost.

There are two basic types of returns from holding and using farm assets. First are capital gains returns which occur from changes in the
value of the assets held over time. Second are earnings returns from the use of the assets in a productive process.

For most assets other than land, and certainly current assets, the use of the assets decreases the value of the asset (depreciation), and except in times of high inflation for farm assets relative to prices in general, capital gains are negligible.

There are separate risks involved in borrowing against future capital gains and earnings returns due to the differences in certainty and variability of these returns. Therefore, a change in either the variability of, or the expected level of either type of return affects the risk of borrowing on those future returns.

Expected capital gains and earnings returns for land have traditionally both been positive (Melichar, 1979, pp. 1085, 1086). Capital gains returns to land come from land price changes over time. Since the capital gains returns are not realized until the land is sold (Plaxico and Kletke, 1979, p. 327), usually at the end of the operation's life, these returns if they are to be utilized for investment, must be used for debt financing. Capital gains returns on land are different than other types of returns in that from the point of view of the operation capital gains are not realized until the land is sold, usually at the time the farm is sold. Earnings returns result from the productive activity for which the land is used.

Of concern when using debt financing, since it is based on expected future returns, is the variability of or lack of certainty in the level of the returns. If the actual returns realized are less than expected
when the debt was incurred, the realized returns may not be enough to repay the debt incurred and the cost of using debt. Several things affect the degree of uncertainty of the returns. One of these is time. The longer the time between when the debt is incurred and when the returns are realized, the more uncertain the expected returns become. This is of special importance when using debt financed by expected capital gains returns on land. The accumulated capital gains from owning land at a point in time may be quite large, but the realized gain if the land is sold at some future time may be much smaller or even negative if land prices decrease in the future. Time also affects the uncertainty of predicted capital gains returns in that the future prediction made is less certain, or more risky, the longer the time until those capital gains are expected to be realized.

The financial structure of the farm sector has changed dramatically over the last 20 years. The liquidity of farms has changed greatly as farmers are holding a smaller percent of their assets as financial assets (United States Department of Commerce, various years). Also, relatively low rates of price increases for farm products relative to increases in machinery and land prices have decreased the percent of total assets that are current assets. This has changed the balance sheet of farmers (Boehlje and Eidman, 1983) even though farm inventories have not changed as dramatically.

This problem is compounded by the fact that not only are longer term assets less liquid but these assets typically generate lower cash flows
than current assets having a larger portion of their returns in the form of capital gains returns.

Farm debt has also changed dramatically in the last 20 years. The average per farm debt in Iowa for farms with debt tripled from 1969 to 1978 (United States Department of Agriculture, 5B706, 1984). While interest rates for farm loans increased 110% from 1965 to 1981 (United States Government Printing Office, 1983). The effect of these changes on financing costs to farmers has been profound.

The increase in debt cannot be solely accounted for because of increases in asset prices, and some increase in leverage has occurred. This also can be somewhat accounted for by the change in the balance sheet of farms since longer term assets have traditionally been leveraged more highly by farmers than current assets; so as long term assets make up a larger portion of the value of total assets, the overall leverage of the farm will increase in the long term, given the traditional leverage percentages of assets.

Increased financing costs have several effects on farm income. There are two causes of increased financing costs, increased amounts of debt and increased interest rates. These have different effects on farm income. Increased debt can come from increasing the leverage of the farm. This gives the farmer control of more assets with the same amount of equity which increases gross returns to assets. Since interest costs increase with an increase in debt, the change in rate of return to equity equity depends on the relative interest rate and the rate of return on assets. The rate of return on equity can be expressed as
\[ e = L(r - i) + r \]

where

- \( e \) = rate of return on equity,
- \( L \) = leverage = \( D/E \),
- \( r \) = rate of return on assets,
- \( i \) = interest rate, after tax,
- \( D \) = debt,
- \( E \) = equity.

As leverage increases the variability of the rate of return to equity increases but at a faster rate. The variance of the rate of return on assets remains constant.

For an increase in interest rates, the rate of return on equity decreases while the variability of returns to assets remains unchanged.

There are two ways the debt load of a farm can change. The first is by the farmer increasing the leverage of the farm. Second is when the value of the assets held increases and the farmer maintains the leverage.

If farmers increase their leverage in the face of increasing interest rates and increasing variability of rate of return on assets, there will be an unambiguous increase in the variability of the rate of return to equity and an ambiguous change in the rate of return to equity.

If there is an increase in asset values and the farmer maintains the same leverage by increasing debt and if the rate of return on assets
remains the same, the rate of return on equity is the same although total net returns increase, with the increased returns comes an increase in variability of income, if the coefficient of variation is unchanged for the rate of returns on assets.

When examining the role of land in a farm, especially a grain farm, the production asset qualities of land are obvious. But the role of land as a financial asset is often overlooked. Land purchases are a store of wealth just as are savings accounts stock portfolios, or the proverbial mattress full of money. As the price of land changes, so does the farmer's wealth. The price of land is in part determined by how well it compares to other assets used to store wealth for example, its returns, risks, ease of acquisition or sale. Also, how the farmer incorporates land into his/her overall financial scheme, affects how land price changes affect the farm's growth and expansion. A 10 percent change in land prices has significantly different effects on a farmer who is highly leveraged than on one who has 100 percent equity. Also a farmer's ability to borrow funds, one form of liquidity, are affected by land price changes differently depending on the proportion of total assets held by the farmer as land.

With the focus of this thesis being the affects of land price changes and variability on farm survival, those factors which cause or are related to land price changes are of interest. The theoretical basis for capital asset pricing is the capitalized value of expected returns from holding that asset. The two primary returns to holding land are one, earning returns from the productive use of the land in the farming
operation and two, the capital gains returns from land price changes while holding the land. Other costs or returns that are less obvious and harder to measure are such things as the added cost of acquiring a given level of funds to maintain the operation of the farm after the acquisition of a parcel of land or the effect of heterogeneity of land on its value.

The capitalization rate used depends upon several things. These include the relative returns available on competing assets, interest rates (real and nominal), and the amount of riskiness of the returns to holding land.
CHAPTER 2. LITERATURE REVIEW

The number of studies on land pricing is as numerous as are the factors being examined. Eberle (1983) and Harris and Nehring (1976) examined the effects of loan terms and land contracts on land prices. Productivity of land was found to be the main determinant in land price differences by Blase and Hosemann (1973) and Hammill (1959). Soil quality and commodity prices were found important in land pricing by Chavus and Shumway (1982). These studies, as well as many others, examined the determinants of land price for one parcel of land at a given time, for given type buyers, in certain locations, under given financial conditions.

All of the above are important in understanding why and how land prices vary from farm to farm. But of more interest to this thesis are the factors that will affect the valuation of all farmland. In other words, what are the basic properties that give land value? To find out, the purchase of land must viewed at its most basic level, as an investment.

Harrington (1983) defines value as, the fair price an investor would be willing to pay for a firm, a portion of a firm, or any other asset. Value is determined by a combination of three factors
1. the size of the anticipated returns,
2. the date that these returns will be received,
3. the risk that the investor takes to obtain the returns.

The first two of Harrington's factors are well-understood and well-researched, as evidenced by the sheer volume of production cost estimates, estimated production functions, and survey data available to
tell farmers what it will take to produce a given crop and the prices the farmer will pay for inputs and receive for outputs. However, the third factor, risk, especially with respect to financial risk, has only recently been given the attention deserved. Shalit and Schmitz (1982) found that savings and accumulated real estate debt were the main determinants of land prices. They showed that the amount of debt land can carry affects its price and that an easing of credit policies by lenders can cause higher land prices. The implications of this are serious if lenders do not realize the effects their policies can have on land prices. If steadily increasing land prices cause lenders to be less restrictive in their lending policies, this can cause increases in land prices and a seemingly endless cycle could be started. Shalit and Schmitz's observations fit the scenario of the steadily increasing land prices and easy credit terms for buying land in the late 1960s and the early and mid-1970s. Shalit and Schmitz allude to the fact that this process could work just as effectively in the other direction in that decreases in the debt carrying capacity of land, for whatever reason, decrease the value of the land. Tweeten and Martin (1966, p. 392) make more of a direct warning:

These results suggest no cause for alarm or panic among land buyers but do sound a note of caution for buyers who could not weather at least the downward adjustment in land values imputed to the speculative element.

It is the link between land prices and lenders' policies that is critical. If lenders are unaware or ignore the effect their lending policies can have on land prices and base their lending policies on past land prices, then they are basing their policies on things that their own
policies are in part determining, and a change in policy could have
dramatic effects.

White and Ziemer (1982) developed a land pricing model that uses
mean land returns, variance of land returns, and the covariance of land
returns and other nonagricultural investment returns to determine land
prices. These last three studies represent a change to viewing land
prices in a more macroeconomic view.

Most of the research on land prices has focused on the demand for
farmland. The supply of farmland in the previously mentioned studies has
usually been assumed to be fixed or at least not price dependent.

In studies examining land prices in a micro concept, i.e., prices
for a certain parcel of land in a given time and place, the number or
rate of land transactions is sometimes included as a parameter in the
land pricing model to estimate the supply of land. The question of
whether the volume of transactions is a proxy for the supply of land as
opposed to a measure of the quantity supplied has not really been
examined. If most land transactions take place for nonprice reasons such
as farmer retirement, the farmer moving, or farm failure, the number of
land transactions would not be expected to be positively correlated to
land prices. Doll et al. (1983) in their examination of variables used
in explaining farmland prices, found that in only 14 of 26 models that
used a measure of the number of transactions as an explanatory variable
was the coefficient of the hypothesized sign. This would support the
idea that farmland availability is independent of land prices, or just
that the number of transactions is not a very good proxy for the supply of farmland.

With approximately 3 percent of the total amount of farmland in the United States transferred each year (Doll et al., 1983), the amount of land that trades is not near the limit. Also, steadily increasing land prices may actually reduce land available for sale in that if expected capital gains from land increase, expected total returns to holding land increase and thereby increase the value of the land to the holder.

Two studies have examined land pricing with specific reference to the issue of land supply. Herdt and Cochrane (1966) take an approach where land prices are determined in a market setting with both supply and demand functions for land. They find that interest rates, the unemployment rate, and the number of farms are relatively important in determining the supply of land. However, they find that the coefficient for interest rates has the wrong sign, i.e., opposite of the hypothesized sign, and is significant. Tweeten and Martin (1966) use a 5-equation recursive model that does not determine land supply directly but that determines the rate of real estate transfers, farm numbers, and land in farms. These are then used as indicators of quantity of land supplied in the determining of land price. Some of the variables Tweeten and Martin used to determine the indicators of land supply were total cropland, the ratio of farm to nonfarm earnings, the unemployment rate, machinery stocks, and capital gains.

Richardson et al. (1983), used a recursive model to study the effects of leasing and leverage on growth and survivability of beginning
Texas High plains cotton farms. A primary conclusion was that maximizing leverage increased the risk of farm failure. They also found that leasing was more profitable than purchasing land or machinery. However, machinery and land prices were assumed to follow the general consumer price index. Given the more rapid rise in land and machinery prices than for the general price level during the late 1960s and 1970s, these results would tend to favor leasing more than if more realistic price changes had been used, since increases in land and machinery prices relative to prices in general would increase real capital gains from owning assets.

Antle (1983) describes the incorporation of risk into production analysis. Antle shows that dynamic production relationships are sufficient to make risk important regardless of whether farmers are risk neutral, risk loving, or risk averse. Antle's efforts are limited to production risk but can be generalized for all types of risk including financial risk.

Baum and Harrington (1983) and Hatch et al. (1982) examine the USDA's typical farm series in which the USDA has developed 20 typical farms based on location and production characteristics. Farm characteristics were determined by survey and from this the effects of different economic situations and political policies can be estimated for these average farms. The effects of different financing strategies was examined; however, the effects of land prices and land price changes were not specifically examined.
Hinman and Hutton (1971) examined the effects of different equity positions of expansion and survivability of Pennsylvania dairy farms. They used management efficiency to indicate levels of expected returns to the operations. Although no specific changes in variance of returns were included in the studies for different levels of returns, high expected returns coupled with high equity positions not only yielded higher net worths and income levels when compared to decreases in the equity or returns, but also resulted in smaller coefficients of variation for both income and net worth.

Patrick and Eisgruber (1968) examined the effects of interest rates, loan limits, and managerial ability on the levels and variability on farm income. They found that more restrictive loan limits delayed or forestalled farm failure of average and low level managers, i.e., middle and low levels of expected returns but reduced the net worths of high ability managers.

Feldstein (1980) developed a theoretical model of land prices that had land prices as part of a portfolio decision made by farmers. Feldstein used tax rates, the marginal physical product of land, price levels, inflation, the price of land, interest rates, land and capital holdings, risk aversion, variance of land returns, and the covariance of land returns and capital returns as determinants of land prices. Feldstein shows that not only after-tax yields are important in determining land prices but that asset yield uncertainty is also important in determining land prices.
CHAPTER 3. THEORETICAL BASIS

Land Values

The value of land as a capital asset comes from capitalizing the future returns expected from holding the land. These returns take two forms, earnings and capital gains. The values of these different types of returns to the farmer are different in that the uses the farmer may put the returns to are different. Earnings returns are received on a regular basis and, once they are received, the farmers can do with them as they see fit. Capital gains returns, on the other hand, occur on a regular basis but are not realized by the farmer until the land is sold. Unrealized capital gains may be borrowed against and those funds put to use to receive their own returns; however, since the capital gains are unrealized, the amount of the capital gain could change before it is realized and after it has been borrowed against.

Therefore, under the Capital Asset Price Method the value of land is

\[
P_o = \frac{E_1}{1 + C_{11}} + \frac{B_1 G_1}{1 + C_{12}} + \ldots + \frac{E_T}{\sum_{i=1}^{T} (1 + C_{ii})} + \frac{B G_T}{\sum_{i=1}^{T} (1 + C_{i2})}
\]  

(3.1)

where \( P_o \) is the present value of an acre of land, \( E_i \) is the expected earnings return in the \( i^{th} \) year, \( C_{ii} \) is the capitalization rate for earnings returns in the \( i^{th} \) year, \( G_i \) is the expected capital gains return in the \( i^{th} \) year, \( B_i \) is the portion of the capital gains that the
farmer may borrow in the $i^{th}$ year, and $C_{12}$ is the capitalization rate for capital gains in the $i^{th}$ year. $T$ is the expected life of the asset in years. This differs in a number of ways from traditional formulas for land values in that both earnings and capital gains are capitalized, not just earnings as in the income valuation approach to land pricing, that the different types of returns are capitalized at different rates and that those rates vary over time.

The Capital Asset Pricing Theory states that the capitalization rate of an asset should reflect both the riskiness of the returns and the correlation of the return of that asset to those of the market in general. So if earnings and capital gains are uncorrelated and/or have different correlations to market returns in general, as suggested by empirical evidence (Montgomery and Tarbet, 1968), the different types of returns represent different risks to the farmer and should be capitalized at different rates. These capitalization rates should also change over time to reflect the level of uncertainty about expected future returns farther in the future.

The exact definition of expected earning returns is an issue of much debate. The $E_i$'s in equation 3.1 should be after-tax earnings and are affected by the leverage of the farm in that debt financing of land entails fixed financing cost which affects earnings. Most of the earlier land pricing models have factors which affect individual farmers expected earnings, $E_i$, or capitalization rate for earnings, $C_{11}$. These include such things as size of operation, managerial efficiency, level of
technology, level of risk aversion, interest rates, or inflation. Some recent work has examined the importance of capital gains to land pricing. Plaxico and Kletke compared different valuations of capital gains. They did not consider risk in specific but used "a discount rate as determined by the opportunity cost of capital or the required rate of return" (Plaxico and Kletke, 1979, p. 327), this doesn't fully incorporate the concept of risk into capitalization.

Most of the land that is sold in Iowa is put on the market by owners where potential buyers can formulate their present value of the land for sale and place bids for it. Land is put on the market by sellers if they feel that their present value of the land compares favorably to the going rate for farmland. This is a general concept of how the land market works.

The supply theory for farmland is not as fully developed as the demand aspects of farmland. At the aggregate level, the supply of land available for sale at different prices is the main issue. However, many things cloud this simple question. One such thing is the heterogeneity of farmland. Not only does the quality of land vary from acre to acre, but the quality of a given acre of land varies from farmer to farmer in that if inputs are considered homogeneous, if they can be substituted for one another without a change in the productivity of the operation, then the land is heterogeneous between producers because of the immobility of land.

Another issue is so called nonprice entry of farmland into the market. This is becoming more of an issue as the failure rate of farms
increases. There are several apparent reasons other than the price of land that may cause farmland to be placed on the market. Herdt and Cochran (1966) list four main categories of nonprice reasons, (1) death, (2) financial, (3) occupational mobility, and (4) location mobility.

The reason these nonprice factors bring farmland into the market is that they lower the value of the farmland to the owners to a point below the going farmland prices. The different types of land owners, owner-operators, and landlords are affected by these factors. For example, landlords may be more likely to sell land and switch to nonland asset than owner-operators if there is a shift in the relative returns of holding land versus nonland assets because owner-operators costs to liquidate may be greater due to the reduced returns on other assets such as machinery, buildings, or even managerial skills if land is sold.

Someone thinking about acquiring or selling land to farm should use a broad scope when examining the value of the land to them. For a speculative land holder, earnings may be limited to the rent available from renting the land out. For an owner-operator or potential owner-operator, the change in total returns for the individual must be taken into account when land transactions are considered. This would include changes in productivity of other assets such as machinery and available labor due to the acquisition of the land. This means that the value of land to a farmer may change as the size of the operation changes. Harris and Nehring show that the maximum bid price for land increases then decreases as farm size increases. Theoretically, this implies an optimal farm size and, given the relatively fixed supply of land, also implies an optimal
number of farms. Each farmer will have a set of maximum bid prices or marginal land values for all parcels of land; also the maximum bid prices will change as the size of the farm varies. The optimal size would vary for each farm due to unique production functions for each farmer. This, in turn, implies that each farmer has a unique maximum bid price. The optimal sized farms and those expanding to optimal size would tend to keep land prices at or near the highest maximum bid level. Land would tend to accumulate in optimal sized farms.

Another issue that must be considered when looking at reasons for the entry of land into the market is that capital gains taxes are only due when those gains are realized not when they are incurred, and therefore the after-tax price received for land is effected by the length of ownership. Capital gains taxes make the after-tax price received by land sellers, who have large unrealized capital gains in their land, less than that for those land owners who have smaller unrealized capital gains for a given sales price. Given the steady increase in land prices during the 1960s and 1970s this would imply that newer farmers would have a higher after-tax price received on the sale of land than older farmers and would therefore, be more likely to sell land if the present value of all land decreased, cetibus peribus. This is important when the increase in the average age of farmers over the last two decades is considered.

An individual will, in theory, buy land when the present value of land is greater than the going land price, and a land owner will sell land when the present value of that land is less than what he/she could receive by selling the land. These two conditions theoretically
determine the quantity supplied and the quantity demanded of land. The factors that change the present value of land determine the supply and demand of land. What complicates this is that each land parcel has a different present value to each potential land owner and that conditions that change the present value of a parcel of land to one person may or may not change the present value of that or any other parcel of land for another person.

The Farm Model

Empirical models and tests performed

The farm model used was developed from the Iowa State University Business and Financing Planning Model. The major revisions are to allow for a more accurate and realistic handling of finances, especially debt, to allow for manipulation of certain variables; primarily land prices, interest rates, credit limits, assets ratios, and debt to asset ratios, to facilitate the evaluation of different policies regarding debt, and expansion under different scenarios of income and prices.

\[
1 \quad \text{NOI}_t = TR_t - VC_t
\]
\[
2 \quad \text{COE}_t = c_1 + c_2 IA_t + c_3 LA_t + I_t
\]
\[
3 \quad \text{NOI}_t = a_0 + a_1 IA_t + a_2 LA_t + e_t
\]
\[
4 \quad \text{NOI}_t = \tilde{\text{NOI}}_t X_t
\]
\( \text{CFO}_t = b_0 + b_1 \text{LA}_t + b_2 \text{LP}_t + \varnothing_t \)

\( \text{NCF}_t = d_0 + d_1 \text{IA}_t + d_2 \text{LA}_t + d_3 \text{GNPD}_{t-1} + d_4 \text{CA}_t + \mu \)

\( \text{TCE}_t = \text{DOE}_t + \text{CFO}_t \)

\( \text{CFO} = \text{CFO}_t \)

\( \text{NCF}_t = \text{NCF}_t \)

\( \text{COE}_t = \text{COE}_t \)

\( \text{LP}_t = B_0 + B_1 (\text{NOI}_t - \text{NOI}_{t-1}) + B_2 (\text{NOI}_{t-1} - \text{NOI}_{t-3}) + B_3 \text{VARNOI}_t \\
+ B_4 \text{VARNOI}\text{VARI}_t + B_5 (\text{LP}_{t-1} - \text{LP}_{t-2}) + B_6 (\text{LP}_{t-2} \text{LP}_{t-3}) \\
+ B_7 \text{RLINT}_t + B_8 (\text{LOANRT}_t - \text{LOANRT}_{t-1}) + B_9 \text{CVLP}_t \)

\( \text{NBTE}_t = \text{INTLHR}_t - \text{NCF}_t - \text{INTP}_t + \text{CAPG}_t + \text{NOI}_t - \text{CFO}_t \)

\( \text{INTLHR}_t = \text{LHF}_{t-1} \cdot r_{4,t} \)

\( \text{INTP}_t = \sum_{T=1}^{M} \sum_{Y=1}^{t} (\text{DEBT}_{Tyt} r_{Tyt}) \)

\( \text{CAPG}_t = \text{ACRSLD}_t (\text{LP}_t - \text{LP}_w) \)

\( \text{NI}_t = \text{NBTE}_t - \text{TAX}_t \)

\( \text{TS}_t = \text{NI}_t + \text{NCF}_t - \text{CAPG}_t + \text{TCE}_{t-1} + \text{ACRSLD}_t \cdot \text{LP}_t \)

\( \text{Tu}_t = \text{PRCP}_t + \text{CONS}_t \)
19 \[ \text{PRCP}_t = \sum_{T=1}^{M} \sum_{Y=1}^{t} \text{DBTP}_{TYt} \]

20 \[ \text{CRLT}_t = m_{1t} \text{CA}_t + m_{2t} \text{IA}_t + m_{3t} \text{LP}_t \cdot \text{LA}_t \]

21 \[ m_{it} = f(r_{TYt}, \text{ANVOI}_t, \text{VARNOL}_t, (\text{GNPD}_{t-1} - \text{GNPD}_{t-1-Y})) \]

22 \[ \text{CRS}_t = \text{CRLT}_t \left( -\text{TOTDT}_t + \text{PRCP}_t \right) - \text{TOTOT}_{t+1} \]

23 \[ \text{TOTDT}_t = \sum_{T=1}^{M} \sum_{Y=1}^{t} \text{DEBT}_{TYt} \]

24 \[ \text{TA}_t = \text{CA}_t + \text{IP}_t + \text{LP}_t \cdot \text{LA}_t + \text{LHF}_t \]

25 \[ \text{DTA}_t = \text{TOTDT}_t - \text{PRCP}_t / \text{TA}_t \]

26 \[ \text{DTAM}_t = f(r_{TYt}, \text{AVNOI}_t, \text{VARNOL}_t) \]

where

\[ \text{NOI}_t = \text{net operating income in time } t, \]

\[ \text{TR}_t = \text{total revenue in time period } t, \]

\[ \text{VC}_t = \text{total variable costs in time period } t, \]

\[ \text{NOI}_t = \text{estimated net operating income in time } t, \]

\[ \text{CA}_t = \text{current assets in time } t, \]

\[ \text{IA}_t = \text{intermediate assets in time } t, \]

\[ \text{LA}_t = \text{acres of land held in time } t, \]

\[ \text{YR} = \text{the time period}. \]
$a_i, b_i, d_i = \text{estimated coefficients},$

$e_t, \phi_t, \psi_t = \text{the random error term}$

$X = \text{a random variable representing the variance in net operating income},$

$\text{CFO}_t = \text{estimated cash fixed expenses in time } t,$

$\text{CFO}_t = \text{cash fixed expenses in time } t,$

$\text{NCF}_t = \text{estimated noncash fixed expenses in time } t,$

$\text{NCF}_t = \text{noncash fixed expenses in time } t,$

$\text{NBTE}_t = \text{net before tax earnings in time } t,$

$\text{INTP}_t = \text{total interest payments in time } t,$

$\text{CAPG}_t = \text{capital gains (losses) from the sale of land in time } t,$

$\text{INTLHF}_t = \text{interest received on financial assets in time } t.$

$\text{DEBT}_{TYt} = \text{outstanding debt, of type } T \text{ issued in period } Y, \text{ in time } t,$

$R_{TYt} = \text{the interest rate in time } t \text{ on a loan of type } T \text{ issued in } Y,$

$\text{NI}_t = \text{net income in time } t,$

$\text{TAX}_t = \text{income tax in time } t,$

$\text{TS}_t = \text{total sources of funds in time } t,$

$\text{TU}_t = \text{total uses of funds in time } t,$

$\text{PRCP}_t = \text{total principal payments in time } t,$

$\text{CONS}_t = \text{family consumption in time } t,$

$\text{DETP}_{TYt} = \text{principal payment in time } t \text{ on } \text{DEBT}_{TYt}.$
\( \text{FATI}_t \) = funds available to invest in time \( t \),
\( \text{NCHF}_t \) = negative cash flow in time \( t \),
\( \text{LP}_t \) = land price in time \( t \),
\( \text{CRLT}_t \) = total credit limit for the farm in time \( t \),
\( m_i \) = collateral value in percent of assets in type \( i \),
\( \text{CSR}_t \) = credit reserve in time \( t \),
\( \text{TOTDT}_t \) = total outstanding of the farm in time \( t \),
\( \text{PRCP}_t \) = principal payments on debt in time \( t \),
\( \text{CRTI}_t \) = credit reserve available for investing in assets in time \( t \),
\( \text{RDC}_t \) = reduction in debt to meet credit limit in time \( t \),
\( \text{TA}_t \) = total assets in time \( t \),
\( \text{LHF}_t \) = financial assets, specifically the land holding fund, in time \( t \),
\( \text{DTA}_t \) = debt to asset ratio of the farm in time \( t \),
\( \text{DTAM} \) = debt to asset ratio maximum,
\( \text{COE}_t \) = estimated cash operating expenses in time \( t \),
\( \text{COE}_t \) = cash operating expenses in time \( t \),
\( \text{TCE}_t \) = total cash expenses in time \( t \),
\( \text{GNPD}_t \) = index of all price levels in time \( t \),
\( \text{AVNOI}_t \) = moving average of per farm net operating income in time \( t \),
VARNOI\textsubscript{t} = variance of NOI during a y year time period in time t,
CVLP\textsubscript{t} = covariance of land prices during last y years at time t,
RLINT\textsubscript{t} = real interest rate in time t,
LOANRT\textsubscript{t} = index of loan interest rates paid by farmers in time t,
ACRSLD\textsubscript{t} = acres of land sold in time t.

Net operating income is the difference between total revenue and variable operating costs (1). Net operating income is estimated from the value of the intermediate assets and the size of the operation in acres (3). Cash operating expenses are estimated from intermediate assets and size of the operation (2). Actual cash operating expenses are assumed to equal estimated expenses (10). Acres of land held is used for estimating NOI instead of total land value because acres more accurately indicates the size of the farm than total land value. Land prices will be exogenously changed in the study and these changes should not affect NOI as defined in the model. NOI in time t is the estimated NOI multiplied by a random variable, X, to simulate the random variance in NOI from year to year (4).

Cash fixed expenses, CFO, are estimated from intermediate assets and land prices (5). Actual CFO equals estimated CFO (8). Total cash expense are equal to the sum of cash operating expenses and cash fixed expenses (7).
Noncash expenses and depreciation are estimated from intermediate assets and a price level index (6). The only assets which in the model are depreciated are intermediate assets. Actual NCF equals estimated NCF (9).

Land prices are estimated from a moving average of per farm net operating income, variance in NOI, the past level of land price changes, variability of land prices, a price level index, an index of returns on nonfarm assets, and an index of interest rates paid by farmers on agricultural loans (11).

Net before tax earnings are equal to net operating income minus fixed costs minus interest payments plus capital gains from the sale of land (15) plus interest received on financial assets (13).

The total interest payment on debt is equal to the sum of interest payments on all outstanding debts (14).

Net income is equal to net before tax income minus the income tax on the income of the farm (16). Total required uses of funds of the farm over operating expenses consist of debt retirement payments and family consumption (18). Total sources of funds for the farm consist of net income plus the total revenue from the sale of any land minus the capital gains from the sale of land plus the amount of noncash fixed expenses plus the amount of funds used to finance cash expenses at the start of the production period (17). Capital gains and noncash expenses are in the above equation since they are noncash items but were included in the calculation of net income; the funds used to finance cash expenses are added back since they subtracted from the stock of funds at the beginning.
of the production period and are not included in the estimate of net operating income.

The funds used to finance cash expenses, $YTCE_t$, are subtracted from the stock of funds at the beginning of the production period to insure that the operation has on hand enough cash reserves or credit reserve to meet necessary cash expense during the year.

Lending institutions are assumed to place a credit limit on the farm based on the collateral value of the assets held by the farm (20). Each type of asset has a different level of collateral value based upon the liquidity of that type of asset and the risk of price changes. The collateral levels that lenders use for determining the credit limit are affected by interest rates, lenders' perceptions of future changes in price levels, and future farm income (21). The credit reserve for a farm is equal to the credit limit for the farm at the beginning of the period minus the outstanding debt of the farm, plus any debt repayments in that period (22).

Total assets at the beginning of a time period are the sum of the current assets, the intermediate assets, the land value, and the financial assets (24).

Farmers are assumed to have a self-imposed maximum debt to asset ratio as a form of financial management policy variable (25 and 26). This ratio can be affected by price changes and changes in expected future income.

Since the purchase or sale of land is usually made in 40 acre increments, funds for the purchase of land must be accumulated until a down-payment can be made that is sufficient for the rest of the purchase price
to be debt financed if debt financing is to be used. Alternatively, the entire value of the purchase must be accumulated if only equity financing is to be used. Also, potential borrowings may be accumulated by not using the full extent of the credit limit. When the sum of these sources is equal to the necessary funds needed, land can be purchased. Funds for the purchase of land can be held one of two ways: first, as financial assets and second, by reducing the outstanding debt on the farm.

How the farmer holds the funds for purchasing land depends upon the returns that can be earned from the funds. If the farmer can earn a higher rate of return as financial assets than as equity in farm assets, then the farmer would prefer to hold them as financial assets and vice versa. If the after-tax returns on holding the funds as financial assets equal the after-tax cost of borrowing funds, there is no difference between holding the funds as financial assets or as equity in the farm when comparing the effect on the financial position of the farm. The reductions in debt from holding the funds as farm equity would add to the credit reserve of the farm by the same amount of the reduction in debt, so when land is purchased, the equity built up in the farm assets can be transferred from the existing assets to the newly purchased land by using the existing assets as collateral to finance the difference between the purchase price of the land and the collateral value of the new land. The farm model is explained in further detail in the Appendix.

**Farm financing**

The process by which the farmer regulates and adjusts the debt structure of the farm is complex given the variety of sources of debt and
debt terms available to farmers. For simplification, it is assumed that there are only three types of debt available to the farmer: current, intermediate, and long term. The terms of the debt are assumed to be the same within each type of debt, current, intermediate, and long term, regardless of the type of lender. Also, the maximum amount of debt extended to a farmer is the same for all lenders, i.e., all lenders use the same criteria for calculating lending limits.

There are two primary credit policy variables used in this analysis. First, is the debt-to-asset ratio of the farm which is an internal policy variable specific to an individual farm. A farmer sets a maximum debt-to-asset ratio that he/she wishes to stay under. Expectations about future returns (both mean and variance), the farmer's level of risk aversion, the farmer's age and family size, the level of off-farm income, and other factors could all influence an individual farmer's choice of a maximum debt-to-asset ratio. The second policy variable is the credit limit available to the farmer. This is determined by the lending institution based upon the collateral value of the assets held by the farmer. These collateral values are affected by many things such as, the lending institution's expectations about the farm economy, future changes in price levels, the availability of loan funds to the lender, and the expected future demand for loan funds. There could also be factors that affect an individual farmer's credit limit such as experience in farming, past production, management, and marketing records.

The two basic sources of funds available for investment and to meet unanticipated needs for funds from unusually low earnings or changes in
technology are net funds generated from the operation of the farm and the
credit reserve of the farm. The credit reserve of the farm is the credit
limit minus the amount of the outstanding debt of the farm at a point in
time.

These funds are used for five purposes: the meeting of debt repay-
ment obligations, family consumption by the farmer and family, replace-
ment of depreciation on intermediate assets, investment in production
expenses for the next production period, and investment in assets for the
expansion of the operation. Debt repayment and consumption expenses are
met by the farmer even if this means a negative net flow of funds in the
operation.

The funds generated from the operation may not meet the need for
funds to run the operation in a given year in which case the net funds
from the operation for that year are negative. This is not an uncommon
occurrence given the production and price uncertainty found in farming.

There are only two ways for the credit limit of a farm to decrease.
One is by a decrease in the value of the assets of the farm and thereby a
decrease in the collateral value of the farms assets; the second is by a
change in the lending institution's lending policies to a tighter credit
policy. During the 30 years before the recent decreases in land price,
the only ways that asset value of the farm decreased given the steady
increases in land prices were from either liquidation of assets or
depreciation of intermediate assets. Until recently, the high rate of
land price increase all but insured an annual increase in the credit
limit of a farm.
The amount of funds at the start of production in the next year, \( t+1 \), after required debt repayment and consumption expenditures, is the sum of the credit reserve at the end of year \( t \), \( CR_s_t \), plus the net flow of funds from operations in year \( t \), \( TS_t - TU_t \), minus the funds necessary to start production year \( t+1 \), \( YTCE_{t+1} \), minus any required investment in intermediate assets to maintain asset ratios. If this amount is greater than zero, funds are available for expansion investment. If the funds are less than zero, additional funds must be acquired from the liquidation of assets to cover the deficit.

**Financial tests**

Since time is divided into discrete segments, production periods or years in this study, it is assumed that the farm must meet certain tests before production can continue in the next period.

The first of these financial tests for the farm is that the sum of the credit reserve and the net funds from operation at the end of the year must be greater than or equal to zero. The net funds from operation in a year could be negative as explained above, and the credit reserve could become less than zero in a year if the credit limit decreases to where it is less than the amount of outstanding debt. Positive net operating funds can be used to repay debt if the credit reserve is negative. Also, a positive credit reserve can be borrowed against to replace negative net operating funds. However, if the sum of the credit reserve and the net operating funds is less than zero then other funds will be needed usually from the liquidation of assets such as the land holding fund.
The second test is the securing of funds to begin the next production period. A certain level of funds, based upon the expected cash expenses for the next period, must be available to purchase production inputs and pay fixed cash costs that will be incurred before any revenue from the operation in the next year is received.

The third financial test deals with asset ratios of the farm to determine if investment must occur to maintain necessary assets ratios. Asset ratios and their maintenance are discussed in the next section.

If the farm has positive net funds available after meeting reserves for future cash expense needs and making required asset investment, the farmer can invest in expansion of the farm operation. If the required needs are not met, liquidation of assets must occur.

When assets must be liquidated, the farmer must determine what assets to sell off. The first and most obvious asset is the land holding fund, LHF. Since it is a financial asset it can be liquidated without affecting the production capabilities of the farm. Once the LHF has been fully liquidated, farm assets must be sold off. The most logical assets to sell off are intermediate assets above the optimal level. The other alternative is the sale of land and a corresponding reduction in current assets.

In either case, when farm assets are liquidated, the amount of funds needed to be raised changes. There are three main reasons for this. The first reason is due to the reduction of the credit limit of the farm when farm assets are sold off. Since the credit limit is based on the assets held by the farmer, the decrease in the credit limit and resulting
resulting lowering of the credit reserve may necessitate the repayment of debt if the CRS becomes negative thus lowering the available funds from the sale of farm assets to meet other needs. The second reason is a decrease in the amount of funds needed to meet expected future cash expenses since those expenses are based in part on the amount of farm assets held. The third reason is if land is sold the optimal level of IA is lowered, and required purchases of IA to maintain optimal asset ratios may be lowered or eliminated; IA in excess of the optimal level may be available for sale.

Since land is sold in discrete size units, it is not likely that the exact amount of assets can be sold to raise the exact amount of needed funds. So if land is sold and enough funds are raised, excess IA will not have to sold. This means that after the LHF is used up, the order of sale of funds is 1) excess IA; 2) 80 acres of CA and no IA; 3) 80 acres, CA and excess IA; 4) 160 acres, CA, and no IA; 5) 160 acres, CA and excess IA. If this last amount of sales does not raise the needed funds, the farm is considered bankrupt and the model run is terminated.

When land is sold, capital gains are incurred if land prices have risen. To minimize the tax burden from the capital gains it is assumed that the farmer will sell off the land that incurs the least possible capital gains.

Also, if excess funds are raised from the liquidation of assets due to the lumpiness of land sales, excess funds will be used to repay debt.
Asset ratios and values

The land held and the amounts of intermediate and current assets held by a farm are highly correlated due to the production relationships of these assets. The ratios of the values of the different types of assets are not only affected by the correlation of the physical assets but also by their relative prices. Since land prices are of major interest to this study, a model of the ratios of the physical amounts of assets is necessary to insure that relative price changes are not allowed to affect the productivity of assets.

If there is assumed to be no change in technology that affects the relative usage of the different types of assets when looking at relative quantities of assets such as tons of fertilizer, tractors of a given horse power, or acres of land, and if there is no outside investment in the farm other than asset replacement, the following rates of change in asset value result.

Current assets are replaced through the operation of the farm and therefore, their value changes by the rate at which the price of those assets changes. So that

\[ CA_{t+1} = CA_t \cdot CADF_t \]

where

- \( CA_t \) = the value of a current asset in time period \( t \),
- \( CADF_t \) = index of current asset prices in time \( t \).
For intermediate assets, depreciation is involved. The change in value of intermediate assets depends upon both the rate of change in intermediate asset prices and the amount of depreciation that occurs, so that

\[ IA_{t+1} = (IA_t - NCF_t)[IADF_t] \]

where
- \( IA_t \) = the value of an intermediate asset in time period \( t \),
- \( NCF_t \) = the amount of depreciation on intermediate assets,
- \( IADF_t \) = index of intermediate asset prices.

The value of land changes with the change in the price of land, since there is no depreciation for land, so that,

\[ LV_{t+1} = (LA_t (LP_t + DLP_t)) \]

where
- \( DLP_t \) = the change in land price in year \( t \),
- \( LV_t \) = total land value in year \( t \),
- \( LA_t \) = acres of land held by the farm in year \( t \).

If the original physical combination of assets is assumed to be optimal from a production efficiency standpoint, to maintain that optimal mix of assets the ratios of the deflated values of the assets must be maintained for efficient production.
Additional investment takes place in the farm over time, to both maintain required asset ratios and for expansion purposes. When investment is made to maintain asset ratios, there is no question of how it will be divided between the different asset types. For expansion, the investment is divided between the asset types in accordance with the ratios of assets based upon the relative values of the different types of assets in order to maintain the initial ratios of physical assets of the farm.

Since the farmer is assumed to acquire the necessary level of current assets through the operation of the farm, only when new land is acquired is a proportional investment in current assets required so that

\[
\frac{CA_0}{LA_0} = \frac{CA_t / CADF}{LA_t} \text{ is maintained at all times.}
\]

Intermediate assets wear out with use (depreciate), land is assumed to have an infinite life span, and current assets are assumed to be replaced through the operation of the farm. Because of these facts, intermediate assets must be replaced in order to maintain a mix of the different types of assets that will maintain the operation at its original level.

\[
CAD_t = a_1 + a_2 LA_t
\]

where

- \( CAD_t \) is current assets in constant dollars in year \( t \),
- \( LA_t \) is a constant value,
a_1 is a constant value, 

a_2 is a coefficient of marginal current asset for a change in acres.

The optimal amount of intermediate assets is

\[ IAD_t = b_1 + b_2 LA_t \]

where

\[ IAD_t \] is intermediate assets in year \( t \) in constant dollars,

\[ b_1 \] is a constant,

\[ b_2 \] is a coefficient of marginal intermediate assets for a change in acres.

To maintain this optimal level of intermediate assets, the deflated value of intermediate assets in any year \( t \), \( IA_t / IADF_t \), divided by the land held in year \( t \), \( LA_t \), must equal the original level. There is some level of intermediate assets per acre that the farmer would or could not let intermediate assets fall below and still expect to continue to produce efficiently. This level can be represented as \( B \) where \( 0 \leq B \leq 1 \).

Therefore, before production can begin in the next year, \( t+1 \), intermediate assets per acre must be greater than this minimum level.

Another complication with asset ratios is that land is bought in 80 acre increments. It is unrealistic for the farmer to wait until land is purchased to start increasing intermediate assets. Since the land
holding fund is used to store funds until land can be purchased, a similar fund could be used to hold funds to increase intermediate assets when land is bought. However, intermediate assets can be purchased in any amount, and observable behavior of farmers would indicate that farmers will acquire intermediate assets above the optimal level in anticipation of future land acquisitions. Therefore, a farmer might divide expansion investment between intermediate assets and the land holding fund so as to keep the level of intermediate assets optimal, not with the actual level of land held, but with the potential land the farmer could hold in year $t$, $LA_t + \left( \frac{LHF_t}{LP_t} \right)$. 
The income, expense, and asset information about Iowa farms was taken from the Iowa State University (various years) annual summaries. The data were from observations on Iowa farms pooled by farm size, in acres, from the years 1964 through 1981. The data used were limited to farms classified as grain farms. The number of observations per year ranged from between 125 to 400 with approximately two-thirds of the observations coming from the two largest classes of farms. The Iowa Farm Business Survey is not a random sample of farms in Iowa. It is a survey done among members of the Iowa farm business association. The members of the association are probably, on the average, better managers, and in better financial positions, than Iowa farmers in general. The effect of this on the results of the study are uncertain but probably raise the level of income for a given size operation. For the period 1978 to 1983, the average net farm income per acre for farms in the Iowa Farm Business Survey was approximately three times as large as for the entire state. But it must be remembered that the state data are for all farms and includes pasture land.

Short term and long term interest rates reflect those charged by Production Credit Associations and Federal Land Banks. The general price level indicator used is the Gross National Product deflator as reported in the 1983 Economic Report to the President.

Land prices were taken from the Iowa Land Value Survey and are based on surveys of licensed real estate brokers in Iowa. The survey
represents a consistent source of land price information for the years 1950 through 1984.

Average net farm income per acre for the entire state was collected from the USDA series, Economic Indicators of the Farm Sector, and is based on total net farm income per farm after inventory adjustment and includes government payments.

United States Department of Commerce data were used to determine relative amounts and types of debt on average farms. Data in the Census of Agriculture divide farms by states and farm type and by farm with debt and all farms. Information on debt divides debt into two categories, real estate and nonreal estate debt. Assets were listed by type. To determine the portions of real estate debt for land and buildings, the real estate debt was divided by the same proportions as the value of the land and buildings. Since farm type data are available only on the national level and state data are for all types of farms to estimate corn farms in Iowa, the differences between all Iowa farms and all U.S. farms were assumed to be the same as between Iowa grain farms and U.S. grain farms. For example, the total debt to total physical farm asset ratio of all Iowa farms is 12.8 percent larger than for all U.S. farms, .291 as compared to .258. It is, therefore, assumed that the TD/TA ratio of Iowa grain farms is 12.8 percent larger than for U.S. grain farms. This gives Iowa grain farms an estimated TD/TA ratio of .308 as compared to .273 for U.S. grain farms and .291 for all Iowa farms. These figures are used for developing beginning average farms to use in the model. The data in USDA SB706 provide information for trends in relative amounts of real estate and nonreal estate debt.
CHAPTER 5. RESULTS

Model Specifications

Income and expenses

The results of the estimations of the income and expense equations for the farm model are presented in Table 1. All coefficients are significant at the 5 percent level except for the intercept term and the land price coefficients in the equation for cash fixed operating expenses, CFO. The $R^2$'s are very high from a low of .85 to a high of .99.

There is a high degree of multicollinearity among most of the independent variables, (see correlation coefficients in Table 2). The severity of this problem is reduced by limiting the number of independent variables in each equation and by the assumption that farms are going to maintain asset ratios similar to those observed in the Iowa Farm Business Survey to maintain optimal efficiency of production.

Asset ratios

Levels of intermediate and current assets in constant dollars were estimated using acres of land, a time trend, and a dummy variable for years after 1973. For intermediate assets, neither the effects of the time trend nor the dummy variable were found to be significant. However, using only acres of land, the model estimated very well, (see Table 3) with an $R^2$ of .94. For current assets, the time trend was not found to be significant if used with the dummy variable, so, therefore only the dummy variable and acres were used.
Table 1. Farm income and expenses. Coefficients, t-values in parentheses, and $R^2$ were estimated with a linear least squares regression (noncash fixed operating expenses, NCF; cash fixed operation expenses, CFO; net operating income, NOI; cash operating expenses, COE).

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Intercept</th>
<th>IA</th>
<th>LA</th>
<th>CA</th>
<th>LP</th>
<th>GNPD</th>
<th>$R^2$</th>
<th>F-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCF</td>
<td>-678.885</td>
<td>0.186172</td>
<td>2.1923</td>
<td>0.04211</td>
<td></td>
<td>759.37108</td>
<td>.9944</td>
<td>3508.6</td>
</tr>
<tr>
<td>CFO</td>
<td>-407.9653</td>
<td>0.419679</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.9130</td>
<td>424.9</td>
</tr>
<tr>
<td>NOI</td>
<td>-9985.38</td>
<td>1.5680</td>
<td>59.5297</td>
<td></td>
<td></td>
<td></td>
<td>.8539</td>
<td>236.8</td>
</tr>
<tr>
<td>COE</td>
<td>-6195.26</td>
<td>0.8527</td>
<td>12.0562</td>
<td></td>
<td></td>
<td></td>
<td>.9713</td>
<td>914.79</td>
</tr>
</tbody>
</table>

**Significant at the 5 percent level.
***Significant at the 1 percent level.
Table 2. Correlation coefficients and probability not correlated in parentheses

<table>
<thead>
<tr>
<th></th>
<th>IAN</th>
<th>LAN</th>
<th>CAN</th>
<th>GNPD</th>
<th>LP</th>
<th>LV</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAN</td>
<td>1.000</td>
<td>.92571</td>
<td>.24477</td>
<td>.22465</td>
<td>.24636</td>
<td>0.02975</td>
</tr>
<tr>
<td></td>
<td>(.0000)</td>
<td>(.0001)</td>
<td>(.0208)</td>
<td>(.0451)</td>
<td>(.0276)</td>
<td>(.7820)</td>
</tr>
<tr>
<td>LAN</td>
<td>1.000</td>
<td>.49696</td>
<td>.38107</td>
<td>.38699</td>
<td>.30162</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(.0000)</td>
<td>(.0001)</td>
<td>(.0005)</td>
<td>(.0004)</td>
<td>(.0041)</td>
<td></td>
</tr>
<tr>
<td>CAN</td>
<td>1.0000</td>
<td>.63414</td>
<td>.61132</td>
<td>.94823</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(.000)</td>
<td>(.0001)</td>
<td>(.0001)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GNPD</td>
<td>1.0000</td>
<td>.98061</td>
<td>.60612</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(.0000)</td>
<td>(.0001)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LP</td>
<td>1.0000</td>
<td>.58701</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(.0000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>LV</td>
<td>1.0000</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(.0000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Constant dollar current (CAD) and intermediate (IAD) assets. Coefficients, t-values, and R^2 estimated by linear least squares regression

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Intercept</th>
<th>LA</th>
<th>GNPD</th>
<th>Dummy Variable</th>
<th>R^2</th>
<th>F-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAD</td>
<td>2390.41</td>
<td>57.5869</td>
<td>4374.475</td>
<td>4374.475</td>
<td>.7680</td>
<td>105.92</td>
</tr>
<tr>
<td></td>
<td>(0.29)</td>
<td>(14.29)*</td>
<td>(2.28)**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IAD</td>
<td>2491.575</td>
<td>25.9850</td>
<td>.9406</td>
<td></td>
<td></td>
<td>1029.8</td>
</tr>
<tr>
<td></td>
<td>(5.88)*</td>
<td>(32.09)*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at the 1 percent level.
**Significant at the 5 percent level.
To check the hypothesis regarding the lack of time trends in the asset ratios, the values of intermediate assets and current assets per acre were calculated from the Iowa Farm Business Survey data and deflated by relevant price indexes. For intermediate assets, the following results were obtained

\[ IALA = 152.24141 - 0.689274 \text{YEAR} \]

\[ \text{df} = 82 \]

which show that for the period 1964 through 1981 in 1977 dollars, deflated intermediate assets per acre did not change significantly. Even though the coefficient for the year was significant at the 90 percent confidence level, the equation only explained 3.4 percent of the total variation (i.e., \( R^2 = 0.0338 \) which would indicate that a time trend explains very little of the variation in intermediate assets per acre of farms in variations in IALA; the \( R^2 \) was only 0.25.

Current assets per acre were also tested to see if a time trend exists. The resulting equation was

\[ CALA = 66.556102 + 1.378911 \text{YR} \]

\[ R^2 = 0.1342 \]

Even though the coefficient was again significant, operation of the overall model was very poor with and \( R^2 \) of only 0.1342.

**Land prices**

In developing the land price models, an effort was made not to use unobservable parameters, because economic theory would suggest that
farmers and others would base bids on land upon their knowledge, not upon unobservable factors.

One of the key relationships in the model is the effect of expected returns to owning land, based on past performance, on the value of land. Expected returns to owning land include both capital gains and earnings returns. Pre-tax capital gains are measured by the past change in land price. Earnings returns are measured by net farm income per acre.

When examining capital gains, two different sets of parameters were examined. The first set is a three-year moving average of past changes in land prices. The second set consists of two parameters, the first is the change in land price during the previous year, and the second the net change in land price for the two years preceding the last year. The second set was found to give better results than the first; this could indicate both expected future capital gains from recent changes in land prices and a wealth effect from past capital gains.

When searching for a proxy of farm income, the availability of data limits the choices available. The ideal parameter would be based on returns to land for grain farming. Two data sets were available. The first is total net farm income for the state of Iowa divided by acres of farmland in the state. The second is from the Iowa Farm Business Association Survey (IFBS). As with changes in land prices two forms of the parameters were used. The first is the level of net farm income per acre, and second is the change in net farm income from year to year.

The state data provided a better fit than the IFBS data. This may be due to the effect of other farm income on farmers' ability or desire to buy farmland since the IFBS data reflect income for only grain farms.
Also examined when estimating land prices of land price change were the effects of the real interest rate, changes in loan interest rates, and moving indexes of the variability in both land prices and net farm income.

Table 4 shows the resulting estimates for the land models. In the model for changes in land prices, the intercept is 16.817 which means that if there had been no changes in land prices or net farm income over the last three years, no change in interest rate from the previous year, and a zero real interest rate, land prices would have increased 16.8 percent in a year. However, this is not a stable point since the increase in land price would affect next year's land price due to both the change in land prices and the variability of past land prices.

Of interest is how variability of net farm income is related to changes in land prices. The coefficient for the variance in net farm income, VRNOI, has a positive sign, the opposite of initially expected. However, the term for the variance of net farm income squared, VNOISQ, is negative. This indicates, given the size of the coefficients, that as variance in net farm income increases, the expected change in land prices starts at zero, first increases then decreases and finally becomes negative. This could be due in part to a correlation between net farm income and variance in net farm income; the correlation coefficient is approximately 0.60.

The coefficient for the effect of the variation of land prices, CVLP, is also of the unexpected sign. This, too, may be due in part to the high correlation between CVLP and DTLPl, the change in land price
Table 4. Land pricing models (land price, LP; percentage change in land price, CHLPP) coefficients, t-values in parentheses, and $R^2$ estimated by linear least squares regression

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Intercept</th>
<th>DTNI&lt;sup&gt;a&lt;/sup&gt;</th>
<th>DTN2&lt;sup&gt;b&lt;/sup&gt;</th>
<th>VRNOI&lt;sup&gt;c&lt;/sup&gt;</th>
<th>CVNOI&lt;sup&gt;d&lt;/sup&gt;</th>
<th>DTLPI&lt;sup&gt;e&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHLPP</td>
<td>16.817</td>
<td>.354</td>
<td>.256</td>
<td>.014</td>
<td>-.052</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.32)***</td>
<td>(2.21)*</td>
<td>(2.30)*</td>
<td>(0.68)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LP</td>
<td>116.034</td>
<td>1.910</td>
<td>5.497</td>
<td>172.155</td>
<td>1.023</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.51)</td>
<td>(0.78)</td>
<td>(2.55)**</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>DTNI = the change in net farm income in the last year.

<sup>b</sup>DTN2 = net change in net farm income in the two years preceding last year.

<sup>c</sup>VRNOI = variability of net farm income per acre in the three previous years.

<sup>d</sup>CVNOI = VRNOI divided by last year's land price.

<sup>e</sup>DTLP1 = change in land price in the last year.

<sup>f</sup>DTLP2 = net change in land price in the 2 years previous to last year.

<sup>g</sup>RLINT = real interest rate; loan interest rate - inflation.

<sup>h</sup>DLR = change in loan interest rate from previous year.

<sup>i</sup>CVLP = variability of land prices over last 3 years divided by last year's price.

<sup>j</sup>SDCVLP = square root of CVLP.

<sup>k</sup>VNOISQ = VRNOI squared.

*Significant at the 10 percent level.

**Significant at the 5 percent level.

***Significant at the 1 percent level.
<table>
<thead>
<tr>
<th>DTLP_2^f</th>
<th>RLINT^g</th>
<th>DLR^h</th>
<th>CVLP^i</th>
<th>SDCVL^j</th>
<th>VNOISQ^k</th>
<th>R^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.335</td>
<td>2.399</td>
<td>.383</td>
<td></td>
<td>-.0000158</td>
<td>.8396</td>
<td></td>
</tr>
<tr>
<td>(-4.69)**</td>
<td>(1.62)</td>
<td>(1.80)*</td>
<td></td>
<td>(1.80)</td>
<td>(1.90)</td>
<td></td>
</tr>
<tr>
<td>1.578</td>
<td>49.644</td>
<td>-17.539</td>
<td>-.0042</td>
<td>.9734</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4.08)**</td>
<td>(2.08)*</td>
<td>(1.63)</td>
<td>(-.52)</td>
<td>(-4.54)**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
last year. The correlation coefficient between CVLP and DTLPl is greater than 0.80 for the years 1960 through 1982. However, adding a quadratic term for CVLP did not help the model.

Model scenarios

In determining what scenarios to run, two starting dates were chosen, 1964 and 1976. Since the model runs for 15 years, the ending years of the runs are 1978 and 1990. Three initial farm sizes were used, 160, 320, and 640 acres. Two initial debt structures will be used: 1) a normal debt load based on Iowa data from the Census of Agriculture and 2) a no-debt structure used on the two smallest farm sizes for 1964 starts and the smallest farm size for 1976.

The five possible initial farm scenarios for 1964 (see Table 5) are first used to check the reliability of the model. This is done by using actual price levels and interest rates observed during that time period.

There are three debt management options available to the farmer. The first is a no-debt option where expansion is be financed only by equity, but debt can be used to meet necessary expenses if there is a temporary shortage of equity funds. The second is an aggressive expansion policy where the farmer sets a relatively high self-imposed debt-to-asset ratio maximum and is therefore, expanding the farm at the earliest opportunity. The third is a more middle of the road approach where the farmer sets aside the value of a portion of the farm, 160 acres, which will not be used as collateral against debt but any assets over the base portion can be borrowed against at the aggressive expansion level.
Table 5. 1964 initial farm scenarios

<table>
<thead>
<tr>
<th>Assets</th>
<th>160</th>
<th>320</th>
<th>640</th>
<th>160</th>
<th>320</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>11,616</td>
<td>20,841</td>
<td>39,291</td>
<td>11,616</td>
<td>20,841</td>
</tr>
<tr>
<td>Intermediate</td>
<td>8,517</td>
<td>12,692</td>
<td>21,042</td>
<td>8,517</td>
<td>12,692</td>
</tr>
<tr>
<td>Long term</td>
<td>46,560</td>
<td>93,120</td>
<td>186,240</td>
<td>46,560</td>
<td>93,120</td>
</tr>
<tr>
<td>Financial</td>
<td>3,335</td>
<td>6,333</td>
<td>12,329</td>
<td>3,335</td>
<td>6,333</td>
</tr>
<tr>
<td>Total</td>
<td>70,028</td>
<td>132,986</td>
<td>258,902</td>
<td>70,028</td>
<td>132,986</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Liabilities</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Short term</td>
<td>4,488</td>
<td>9,672</td>
<td>20,265</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Intermediate term</td>
<td>3,292</td>
<td>5,889</td>
<td>10,854</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Long term</td>
<td>7,572</td>
<td>15,143</td>
<td>30,286</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>15,352</td>
<td>30,704</td>
<td>61,405</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

| Net worth    | 54,676 | 102,282 | 197,497 | 70,028 | 132,986 |

For both the 1964 and 1976 runs long term debt has (1) a 20 twenty year repayment schedule, (2) no balloon repayment, and (3) variable interest rates. Intermediate term debt is for two years with 50 percent of the principal due each year. Short term debt has a one year term.

The credit limit is equal to 20 percent of the current assets plus 75 percent of the sum of intermediate and long term assets.

Intermediate asset rates are allowed to drop to 85 percent of the desired level, based on the optimal asset ratio, before investment in intermediate assets is required to restore asset ratios.

Consumption by the farmer is determined by the level of net operating income. If net operating income is less than or equal to zero, then consumption is set at $10,000. If net operating income is positive but less than $100,000, consumption is set at $15,000. And for levels of
net operating income greater than $100,000, consumption is $20,000. No provisions are made in the model for off-farm income, but off-farm income could easily be added in.

The 1976 starts are of interest in that forecasts can be under different scenarios of future trends in prices and interest rates.

The net farm income per acre for the state can be broken down into two periods 1964-1971 and 1972-1983. For the earlier period, the mean level net farm income and the coefficient of variation are both lower than for the later period (see Table 6).

Reinders discusses the triangular distributions to generate Monte Carlo variates (Reinders, 1983, p. 163). The parameters of the triangular distributions are presented in Table 7.

Both periods evidence plalykurtic behavior relative to a normal distribution; therefore, more than 95 percent of the distributions are included in the triangular distributions.

To forecast for the period 1984 through 1990, estimates were needed for the current and intermediate asset price indexes, the GNP deflator, long term and short term interest rates, the level and variability of net farm income, and land prices. The predicted land prices are in part based on the assumptions about the other variables.

For the price and interest rate indexes for the period 1985-1990, two sets of values are examined, see Table 8. Set A is based on the period 1982-1984 using an inflation rate for the GNP deflator of 4.47 percent and a real interest rate of 8.417 percent. The current and intermediate asset price indexes were assumed to grow relatively slowly
Table 6. Statistical measures of net farm income per acre for Iowa

<table>
<thead>
<tr>
<th>Period</th>
<th>Mean $\bar{X}$</th>
<th>Standard deviation</th>
<th>Skewness $(\gamma_1)^*$</th>
<th>Kurtosis $(\gamma_2)^{**}$</th>
<th>Coefficient of variation (CV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972-1983</td>
<td>41.100</td>
<td>22.66</td>
<td>-0.331</td>
<td>-0.035</td>
<td>.5513</td>
</tr>
<tr>
<td>1964-1971</td>
<td>28.43</td>
<td>4.25</td>
<td>-0.347</td>
<td>-1.196</td>
<td>.1495</td>
</tr>
</tbody>
</table>

$^* \gamma = \frac{\sum (x_i - \bar{x})^3}{n} \left( \frac{\sum (x_i - \bar{x})^2}{n} \right)^{3/2}$

$^{**} \gamma = \frac{\sum (x_i - \bar{x})^4}{n} \left( \frac{\sum (x_i - \bar{x})^2}{n} \right)^2 - 3$

Table 7. Parameters of triangular distribution with probability of ninety-five percent (P=.95)

<table>
<thead>
<tr>
<th>Period</th>
<th>Lower limit $A$</th>
<th>Upper limit $B$</th>
<th>Mode $M$</th>
<th>Mean $\bar{X}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972-1983</td>
<td>-0.078</td>
<td>2.078</td>
<td>0.8175</td>
<td>1.000</td>
</tr>
<tr>
<td>1984-1971</td>
<td>0.706</td>
<td>1.294</td>
<td>0.9481</td>
<td>1.000</td>
</tr>
<tr>
<td>Year</td>
<td>GNP deflator</td>
<td>Average loan rate</td>
<td>Real interest rate</td>
<td>Current asset price index</td>
</tr>
<tr>
<td>------</td>
<td>--------------</td>
<td>-------------------</td>
<td>-------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Set A</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>3.999</td>
<td>12.89</td>
<td>8.417</td>
<td>5.879</td>
</tr>
<tr>
<td>89</td>
<td>3.828</td>
<td>12.89</td>
<td>8.412</td>
<td>5.551</td>
</tr>
<tr>
<td>86</td>
<td>3.357</td>
<td>12.89</td>
<td>8.417</td>
<td>4.666</td>
</tr>
<tr>
<td>85</td>
<td>3.213</td>
<td>12.89</td>
<td>8.417</td>
<td>4.434</td>
</tr>
<tr>
<td>84</td>
<td>3.076</td>
<td>12.10</td>
<td>8.424</td>
<td>4.183</td>
</tr>
<tr>
<td>83</td>
<td>2.963</td>
<td>13.00</td>
<td>8.942</td>
<td>3.96</td>
</tr>
<tr>
<td>82</td>
<td>2.843</td>
<td>13.56</td>
<td>7.845</td>
<td>3.84</td>
</tr>
<tr>
<td>81</td>
<td>2.682</td>
<td>14.20</td>
<td>5.744</td>
<td>3.65</td>
</tr>
<tr>
<td>80</td>
<td>2.455</td>
<td>12.22</td>
<td>3.700</td>
<td>3.31</td>
</tr>
<tr>
<td><strong>Set B</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>84</td>
<td>3.076</td>
<td>12.10</td>
<td>8.424</td>
<td>4.245</td>
</tr>
<tr>
<td>83</td>
<td>2.963</td>
<td>13.00</td>
<td>8.942</td>
<td>3.96</td>
</tr>
<tr>
<td>82</td>
<td>2.843</td>
<td>13.56</td>
<td>7.885</td>
<td>3.84</td>
</tr>
<tr>
<td>81</td>
<td>2.682</td>
<td>14.20</td>
<td>5.744</td>
<td>3.65</td>
</tr>
<tr>
<td>80</td>
<td>2.455</td>
<td>12.22</td>
<td>3.700</td>
<td>3.31</td>
</tr>
</tbody>
</table>

\[a_{1964} = 1.00.\]
with respect to the GNP index, 1.8 percent per year for the current asset
price index and 3.3 percent per year for the intermediate asset index.
Set B is based on the period 1974-1981 with an average rate of increase
in the GNP deflator of 7.362 percent and an assumed real interest rate of
2.108 percent. Also, the current and intermediate asset price indexes
were assumed to grow at faster rates relative to the GNP deflator; 3.78
percent per year for the current asset index and 4.78 percent per year
for the intermediate asset index.

The land price model is not well-suited to make long term forecasts
for land prices due to the relatively large impact of short term changes
of the variables on land prices, for example, a $30 per acre increase in
net farm income. With everything else the same, almost a 10 percent
increase in land price the next year could occur. However, estimating
yearly levels of farm income is much more difficult and is subject to
greater error than estimating general levels of net farm income for
longer periods of time. This does not mean that the model is useless;
the effect of changes in the general level of variables on land prices
can be examined. For example, an increase in the average level of net
farm income of $10 per acre would, given everything else remaining
constant, indicate an increase in land prices of approximately 8.9
percent given the combined affects of a change in net farm income through
the DTN1 and DTN2 variables (see Table 4). In this way, the land price
model can be used to adjust expected future land prices when using
different scenarios of other variables. Thus, if the farm model is run
under a new scenario of higher inflation or lower variability of net farm
income proper adjustments can be made to expected land prices to reflect these other changes and, therefore, the full effect of these changes on farmers financial conditions can be better understood.

To sum up, for the 1964 starting date there are three farm sizes. Two of which are examined under a no debt situation, and for the runs with debt, there are three debt management options. For the 1976 starting date, there are three farm sizes, one of which is examined under a no debt situation. For the runs with debt, there are three debt management options; for the period after 1984, there are two sets of macro economic indicators and two levels of possible net farm income.

Between 1981 and 1984, farmland prices in Iowa dropped by over one-third and in 1984 land prices were actually slightly less than in 1976. Whether land prices decline over the next five years depends upon many factors. The two main factors, in broad categories, are expectations about farm income and interest rates. Although these two areas are not independent, it is convenient to examine each in turn.

Farm income during the 1970s and early 1980s has been quite variable, but the average is larger than during the 1960s. However, the last three years have all been well below average. If the government's farm program falls under the guise of budget cuts and is left to Reagan's "free markets", farm income may remain at present low levels or decline even further given the pressure on exports due to the high value of the dollar. If, however, the dollar declines in value and farm price supports have been reduced, farm income could remain variable at high levels due to movements in the world demand for food. If the Congress
modifies farm income supports, they will most probably be at lower levels and will dampen market fluctuations.

The interest rate is also involved with the value of the dollar. If interest rates remain high relative to the inflation rate, the value of the dollar will probably remain high. But if interest rates fall to meet the decrease in inflation, the pressure on the dollar may be relaxed.

The interaction of future interest rates and farm income are expressed in three basic scenarios:

1. continued low farm income and high interest rates,
2. higher and more variable farm income and lower interest rates,
   and
3. lower farm income and lower interest rates.

These scenarios have different effects on future land prices. The first scenario has the worst potential effect on land prices. Using the coefficients from the land price model as rough approximations of the partial effects on land prices, the relative changes in land prices under the three scenarios would be under scenario 1) -20%, 2) +15%, and 3) +5%. If the land price decreases of the 1920s and 1930s are used as a guide, an overall land price decrease of over 50 percent would not be unexpected. This would mean further land price decreases of 20 percent from prices at the end of 1984. This, coupled with the effects of changes in farm income and interest rates, would imply land prices bottoming out at $870 per acre for scenario (1), $1250 per acre for scenario (2), and $1140 per acre for scenario 3). The estimated land prices for 1985 to 1990 are presented in Table 9. Under an assumption
<table>
<thead>
<tr>
<th>Year</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>$1114</td>
<td>$1304</td>
<td>$1249</td>
</tr>
<tr>
<td>1986</td>
<td>870</td>
<td>1250</td>
<td>1140</td>
</tr>
<tr>
<td>1987</td>
<td>909</td>
<td>1300</td>
<td>1186</td>
</tr>
<tr>
<td>1988</td>
<td>950</td>
<td>1352</td>
<td>1233</td>
</tr>
<tr>
<td>1989</td>
<td>993</td>
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<td>1282</td>
</tr>
<tr>
<td>1990</td>
<td>1037</td>
<td>1462</td>
<td>1334</td>
</tr>
</tbody>
</table>

that it will take two years after 1984 for land prices to bottom out with land prices rising at a two percent real rate similar to the 1960s.

Simulation Results

1964 runs

In reviewing the results of 1964 through 1978 model runs, it is important to remember that land values grew at an average of 12.2 percent per year over that time.

There were seven test farm models run for the 1964-1978 time period, they were:

1. A 160 acre farm with an initial debt to asset (DTA) ratio of 0.219 and a desired maximum DTA ratio of 0.4.
2. A 160 acre farm with initially no debt and a maximum desired DTA ratio of 0.1
3. A 320 acre farm with an initial DTA ratio of 0.231 and a desired maximum DTA ratio of 0.4.
4. A 320 acre farm with an initial DTA ratio of 0.231 and a desired maximum DTA ratio of 0.4 on assets in excess of those necessary for a 160 acre farm.
<table>
<thead>
<tr>
<th>Scenario 1</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>12.22%</td>
<td>13.56</td>
<td>3.214</td>
<td>5.551</td>
<td>4.454</td>
</tr>
<tr>
<td>1986</td>
<td>12.22</td>
<td>13.56</td>
<td>3.359</td>
<td>5.950</td>
<td>4.723</td>
</tr>
<tr>
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<td>13.56</td>
<td>3.510</td>
<td>6.379</td>
<td>5.009</td>
</tr>
<tr>
<td>1988</td>
<td>12.22</td>
<td>13.56</td>
<td>3.668</td>
<td>6.838</td>
<td>5.312</td>
</tr>
<tr>
<td>1989</td>
<td>12.22</td>
<td>13.56</td>
<td>3.833</td>
<td>7.330</td>
<td>5.633</td>
</tr>
<tr>
<td>1990</td>
<td>12.22</td>
<td>13.56</td>
<td>4.006</td>
<td>7.858</td>
<td>5.974</td>
</tr>
<tr>
<td>Scenario 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1985</td>
<td>9.67</td>
<td>10.73</td>
<td>3.199</td>
<td>5.499</td>
<td>4.412</td>
</tr>
<tr>
<td>1986</td>
<td>8.34</td>
<td>9.26</td>
<td>3.327</td>
<td>5.867</td>
<td>4.657</td>
</tr>
<tr>
<td>1987</td>
<td>8.34</td>
<td>9.26</td>
<td>3.460</td>
<td>6.260</td>
<td>4.915</td>
</tr>
<tr>
<td>1988</td>
<td>8.34</td>
<td>9.26</td>
<td>3.598</td>
<td>6.680</td>
<td>5.188</td>
</tr>
<tr>
<td>1989</td>
<td>8.34</td>
<td>9.26</td>
<td>3.742</td>
<td>7.127</td>
<td>5.476</td>
</tr>
<tr>
<td>1990</td>
<td>8.34</td>
<td>9.26</td>
<td>3.892</td>
<td>7.605</td>
<td>5.780</td>
</tr>
<tr>
<td>Scenario 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1985</td>
<td>9.67</td>
<td>10.73</td>
<td>3.199</td>
<td>5.499</td>
<td>4.412</td>
</tr>
<tr>
<td>1986</td>
<td>8.34</td>
<td>9.26</td>
<td>3.327</td>
<td>5.867</td>
<td>4.657</td>
</tr>
<tr>
<td>1987</td>
<td>8.34</td>
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<td>6.260</td>
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<tr>
<td>1988</td>
<td>8.34</td>
<td>9.26</td>
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<td>6.680</td>
<td>5.188</td>
</tr>
<tr>
<td>1989</td>
<td>8.34</td>
<td>9.26</td>
<td>3.742</td>
<td>7.127</td>
<td>5.476</td>
</tr>
<tr>
<td>1990</td>
<td>8.34</td>
<td>9.26</td>
<td>3.892</td>
<td>7.605</td>
<td>5.780</td>
</tr>
</tbody>
</table>

\(^{a}1964 = 1.00.\)

\(^{b}0 = \text{low level}, \mathit{l}=\text{high level}.\)
5. A 320 acre farm with no initial debt and a desired maximum DTA ratio of 0.1.

6. A 640 acre farm with an initial DTA ratio of 0.237 and a desired maximum DTA ratio of 0.4 on assets in excess of those necessary for a 160 acre farm.

7. A 640 acre farm with an initial DTA ratio of 0.237 and a desired maximum DTA ratio of 0.5.

The results were quite varied from 100 percent of the farms going bankrupt in run number 1 to 100 percent of the farms having more than 4000 acres in number 7.

In run number 1, the farms started with an initial net worth of $54,676. Out of the 35 simulations only one farm survived past the 9th year of the simulation and it failed in the 12th year. All the rest failed between the 7th and 9th years. The main problem with these farms was that these farms' income could not sustain the levels of cash expenditures incurred by the farms and, therefore, the equity base of the farms eroded, despite increases in land values, until the point when cash expenses of the farm could not be financed.

It should be noted that when a farm goes bankrupt in the model, it does not necessarily mean it has a negative net worth. The model will declare a farm bankrupt when the sale of 160 acres of land, the sale of accompanying current and intermediate assets, and the raising of debt levels to the maximum allowed by lenders above and beyond the desired maximum DTA ratio, will not raise the necessary funds that will allow the farm to start the next production cycle.
In the second run, 32 percent of the farms failed having an average net worth of $43,195 when declared bankrupt. The farms that successfully completed the run had an average net worth of $112,147 and a DTA ratio of .497 with an average of 94 acres. This still represents a significant outflow of funds due to the difference between income levels and consumption.

The results of the first two runs do not seem unrealistic in light of the fact that off-farm income is not included in the model. Given the large portion of total farmers' income accounted for by off-farm income many of these small farms could have remained viable with infusion of off-farm income.

For the runs of 320 and 640 acre farms, there were no failures, this would indicate that these size farms could support the farmer's consumption from farm income and capital gains without endangering the financial condition of the farm.

In run 3, the initial net worth of the farms was $102,282; at the end, the average net worth was $735,263 with a DTA ratio of .357 with an average size of 598 acres. This represents an average yearly increase in net worth of 14.1 percent, well above the average increase in asset values. The ending DTA ratio of .357 is less than the desired maximum of .4 in part due to the rapid increases in asset values and also to the lumpiness of land purchases.

Run 4 is best described as one of no change. In none of the simulations did any farms buy or sell land. The DTA ratio rose slightly from .231 to .248. Total debt increased by 418 percent but this was matched
by an increase in total assets of 385 percent. Net worth increased from $102,282 to $483,552 an average yearly increase of 10.9 percent. An interesting note, even though the farms DTA ratio did not change dramatically, is that only 17 percent of the farms were able to reduce the DTA ratio to below the desired maximum level. The initial DTA ratio of .231 was greater than the desired maximum of .189.

Run 5 has a low debt policy yet has a larger increase in net worth than run 4, an 11.8 percent annual increase. This is due to the fact that at the start of each simulation run the initial level of debt is below the desired maximum level. This is reflected by an increase in acres from 320 to 415.

In run 6, all variables increase. Net worth increases from $197,497 to $2,401,816. The average size increases to 1,782 acres. Total debt increases by over 15 times to $948,999. However, the DTA ratio only increases from .237 to .358 which reflects the increase in the desired maximum DTA ratio from .19 to .36 as the average farm size increases.

Run 7 had to be discarded for a couple of reasons. First, the farm grew to be too large. The model is only capable of handling up to 4,000 acres of land transactions, and in run 7, all the farms reached the 4,000 acre limit well before the end of the 15-year simulation. Second, the income and expense estimates and the asset ratios in the model were not developed to include such large size farms. Moreover, the accuracy of the model under these circumstances is questionable.

During the period 1964-1978, high returns to farming were available, mostly in the form of capital gains from increases in land and machinery
values. Smaller farms were dependent on capital gains to meet consumption demands which were not met by farm income, thus impeding the use of these funds for expansion, and raising debt loads since those capital gains are only available for use by debt financing or sale of the assets. The results of the runs are summarized in Table 11.

1976 runs

The runs for the 1976-1990 period can be divided into two periods, 1976-1984 and 1985-1990. Of interest is the effect of the downward trends in land prices after 1981 on the financial conditions of the test farms and the implications of the three hypothesized future scenarios on those financial conditions.

Six different test farms were used for analysis. They are:
1. A 320 acre farm with an initial DTA ratio of .154 and a desired maximum DTA ratio of 0.4 on assets in excess of those for a 160 acre farm.
2. A 320 acre farm with an initial DTA ratio of .154 and a desired maximum DTA ratio of 0.4.
3. A 640 acre farm with an initial DTA ratio of .158 and a desired maximum DTA ratio of 0.4 on assets in excess of those for a 160 acre farm.
4. A 640 acre farm with an initial DTA ratio of .158 and a desired maximum DTA ratio of 0.4.
5. A 640 acre farm with an initial DTA ratio of .316 and a desired maximum DTA ratio of 0.4 on assets in excess of those for a 160 acre farm.
Table 11. Farm model results for 1964 starting date runs

<table>
<thead>
<tr>
<th>Run</th>
<th>Acres</th>
<th>Initial</th>
<th>Ending</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>160</td>
<td>70,028</td>
<td>15,352</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>DTA ratio</strong></td>
<td>.219</td>
</tr>
<tr>
<td>2</td>
<td>160</td>
<td>223,016</td>
<td>110,889</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>DTA ratio</strong></td>
<td>.497</td>
</tr>
<tr>
<td>3</td>
<td>320</td>
<td>1,143,595</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>DTA ratio</strong></td>
<td>.357</td>
</tr>
<tr>
<td>4</td>
<td>320</td>
<td>642,616</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>DTA ratio</strong></td>
<td>.248</td>
</tr>
<tr>
<td>5</td>
<td>320</td>
<td>801,547</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>DTA ratio</strong></td>
<td>.118</td>
</tr>
<tr>
<td>6</td>
<td>640</td>
<td>3,350,815</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>DTA ratio</strong></td>
<td>.358</td>
</tr>
</tbody>
</table>
6. A 640 acre farm with an initial DTA ratio of .316 and a desired maximum DTA ratio of 0.4.

Each of the six test farms was run under the three different price and income scenarios.

The results for the period 1976-1984 are the same regardless of the price scenario and are examined first. Next, the relative effects of the different price scenarios are examined.

**640 acre farms with moderate initial debt** Both of the 640 acre farms started with the same levels of assets and debt in 1976. By 1981, the peak land price year, the net worth of the farm with the more aggressive financial policy, run 4, had increased by 87.9 percent as compared to 74.3 percent for the more conservative farm. However, the debt level of the more aggressive farm had increased by 554 percent as compared to only 261 percent for the more conservative farm. The conservative farm had obtained 85 percent of the aggressive farm's increase in net worth while only increasing debt by 47 percent as much.

By 1984, the last year that is the same under all the price scenarios, the net worth of the aggressive farm had fallen to 86 percent of the initial 1976 level. The net worth of the conservative farm also fell from 1981 to 1984 but was still at a higher level than in 1976. The change in debt for the 81 to 84 period again marks the major contrast between the two debt management policies. Total debt increased for both farms by approximately 10 percent; however, the total debt of the aggressive farm was 86 percent greater than the conservative farm; this is due to the larger build-up of debt during the 1976 to 1981 period.
Both farms in 1984 are at higher than desired DTA ratios. The aggressive farm has a DTA ratio of .618, and the conservative farm has a DTA ratio of .414.

No farms have failed as of 1984. However, for the aggressive farm about 10 percent of the farms will fail in 1985 regardless of the price scenario used.

The price scenarios have different effects on the different farms. For the aggressive farms, the main difference between the different price scenarios is the level of farm failures. At the end of the 15 year simulation, 1990, there is less than a 1 percent difference in the net worth of the surviving farms. In 1986, the bottom of the land price cycle, the net worth of the farms varies by up to 30 percent. The catching up in net worths can be attributed in part to the differences in failure rates. Under scenario 1, 71 percent of the farms fail between 1986 and 1990 under scenario 2, 14.3 percent fail; and under scenario 3, 18.8 percent fail.

For the conservative farm, the differences due to the price scenarios are most evident in the ending net worths. In 1990, under scenario 2, the ending net worth is 63 percent larger than under scenario 1, and under scenario 3, is 36 percent larger than under scenario 1.

The farm failure rates are lower for the conservative farm under all price scenarios than for the aggressive farms with no failure under scenarios 2 and 3 for the conservative farm and a 6.7 percent failure rate under scenario 1.
For scenarios 2 and 3, the ending DTA ratio is lower for the conservative farm than for the aggressive farm. But under scenario 1, the ending DTA ratio is lower for the aggressive farm. This is due to the higher failure rate for the aggressive farm where only those who had much higher than average equity positions remained viable.

The results for the 640 acre farms are summarized in Table 12.

Table 12. 1976 640 acre farm simulations with .158 initial DTA ratios

<table>
<thead>
<tr>
<th>Year</th>
<th>Scenario</th>
<th>Total assets</th>
<th>Total debt</th>
<th>DTA ratio</th>
<th>Acres</th>
<th>Net worth</th>
<th>Percent failures</th>
</tr>
</thead>
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<tr>
<td>Conservative debt policy</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>1976</td>
<td>-</td>
<td>$1,027,876</td>
<td>$162,404</td>
<td>.158</td>
<td>640</td>
<td>$865,472</td>
<td></td>
</tr>
<tr>
<td>1981</td>
<td>-</td>
<td>2,095,177</td>
<td>386,650</td>
<td>.280</td>
<td>870</td>
<td>1,508,528</td>
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<tr>
<td>1984</td>
<td>-</td>
<td>1,556,209</td>
<td>644,270</td>
<td>.414</td>
<td>871</td>
<td>911,938</td>
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<td>1</td>
<td>1,166,972</td>
<td>687,347</td>
<td>.589</td>
<td>869</td>
<td>708,889</td>
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<td>2</td>
<td>1,511,968</td>
<td>665,266</td>
<td>.440</td>
<td>868</td>
<td>846,702</td>
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<td>3</td>
<td>1,396,255</td>
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<td>871</td>
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<td>1,411,480</td>
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<td>811</td>
<td>721,266</td>
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<td>2</td>
<td>1,818,450</td>
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<td>.354</td>
<td>865</td>
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<td>692,713</td>
<td>.413</td>
<td>866</td>
<td>984,557</td>
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<td>Aggressive debt policy</td>
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<tr>
<td>1976</td>
<td>-</td>
<td>$1,027,876</td>
<td>$162,404</td>
<td>.158</td>
<td>640</td>
<td>$865,472</td>
<td></td>
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<tr>
<td>1981</td>
<td>-</td>
<td>2,687,538</td>
<td>1,061,578</td>
<td>.395</td>
<td>1,083</td>
<td>1,625,960</td>
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<tr>
<td>1984</td>
<td>-</td>
<td>1,943,145</td>
<td>1,200,864</td>
<td>.618</td>
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<td>1,426,254</td>
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<td>2</td>
<td>1,845,000</td>
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<td>.624</td>
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<td>1,105,386</td>
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<td>999</td>
<td>621,780</td>
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<td>1</td>
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<td>.362</td>
<td>800</td>
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<td>71</td>
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<td>2,220,364</td>
<td>1,129,610</td>
<td>.509</td>
<td>1,000</td>
<td>1,090,754</td>
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<td>2,112,293</td>
<td>1,022,350</td>
<td>.484</td>
<td>945</td>
<td>1,089,943</td>
<td>19</td>
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</table>
The 640 acre farms with .316 initial DTA ratios are the same as the other 640 acre farms except that the amount of debt carried by the farms at the start of the simulations was doubled. In the lower debt runs, both 320 acres and 640 acres, the farms had lower DTA ratios than the desired maximums. In these runs, the conservative debt policy farm is at a DTA ratio greater than the desired maximum while the aggressive farm is still slightly below its desired maximum DTA ratio. This is observable in the changes in DTA ratios between 1976 and 1981. The DTA ratio of the conservative farm's, run 5, decreases from .316 to .275 while the DTA ratio of the aggressive farm, run 6, increases to .396 from .316. What is very noticeable is that, while in this same time period the total debt of the conservative farm increases in absolute level by 51 percent as compared to 166 percent for the aggressive farm, the increases in net worth are nearly identical, 84 percent for the conservative farm and 87 percent for the aggressive farm.

During the period of observed land price decreases, 1981-1984, the added risk of the aggressive debt policy becomes evident. Total debt continues to increase for both farms, but the increase for the aggressive farm is 225 percent greater than for the conservative farm. The differences in the decreases in net worth are also very marked. The net worth of the conservative farm falls by 40 percent from the 1981 level but is still greater than the 1976 net worth. The net worth of the aggressive farm falls by 60 percent from 1981 to 1984 and is 20 percent less than the 1976 level.
In 1984, the DTA ratio of the aggressive farm is 50 percent larger than that of the conservative farm, .633 versus .396. Also, 8.6 percent of the farms fail between 1981 and 1984 under the aggressive debt policy with none failing under the conservative debt policy in the same period.

The effect of debt policy on farm failure rates is also evident in the period 1986 through 1990. Under the conservative debt policy, there are no failures under any of the three price scenarios. Under the aggressive debt policy, there are between 3 and 6 percent failures between 1986 and 1990 and with price scenario 1, there is a 65 percent farm failure rate between 1986 and 1990.

For price scenarios 2 and 3, the DTA ratios under the aggressive debt policy are about 50 percent greater than under the conservative debt policy for the period 1986 through 1990. Also, the ending net worths are similar for all the debt policies with the conservative farm's net worth being slightly higher.

The results for price scenario 1, are very much different, not only across price scenarios but also across debt policies. For the conservative farm under scenario 1 the DTA ratio is the highest of the three and the net worth the lowest. In fact, the ending net worth under scenario 1 is less than the initial, 1976, net worth. This reveals the impact of further major land price decreases.

Under the aggressive debt policy, the results are just the opposite. The scenario 1 DTA ratio is the lowest and its net worth is between the other two. This can be accounted for by the fact that the figures represent only the farms still viable in that year which for scenario 1
in 1990 is less than 30 percent of the starting farms. In 1986, before most of the failures in scenario 1, the relationship of the DTA ratio and the net worths between the three price scenarios is similar to that observed under the conservative debt policy so that the apparent good shape of the surviving farms under scenario 1 with the aggressive debt policy is due, in part, to the fact that all the farms that had not had higher than average levels of income in the 1986-1990 period went out of business.

The results of the 640 acre farm simulations with initial DTA ratios of .316 are presented in Table 13.

320 acre farm As with the 640 acre farm, both of the 320 acre farms started with the same levels of assets and debt. By 1981, the level of debt for the farm with the aggressive debt policy, run 1, had increased by over 500 percent, yet net worth had increased by only 71 percent. For the farm with the conservative debt policy, run 2, by 1981 net worth had increased by 61 percent and debt by only 119 percent.

By 1984, the last year that is the same under the three different price scenarios, the DTA ratio for the aggressive farm had risen to .642, a four-fold increase from 1976. The DTA ratio of the conservative farm in 1984 was .300, less than half that of the aggressive farm. The level of debt for the conservative farm was only 35 percent that of the aggressive farm, but the conservative farm had a net worth 45 percent greater than the aggressive farm.

For the aggressive farms, approximately 10 percent fail in 1985 under all three price scenarios. For the aggressive farms, there are
Table 13. 1976 640 acre farm simulations with .316 initial DTA ratios

<table>
<thead>
<tr>
<th>Year</th>
<th>Scenario</th>
<th>Total assets</th>
<th>Total debt</th>
<th>DTA ratio</th>
<th>Acres</th>
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<th>Percent failures</th>
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<td>.316</td>
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both differences in failure rates and ending net worths between the different price scenarios. Under price scenario 1, another 15 percent of the farms fail between 1986 and 1990, whereas there are no additional failures after 1985 under either price scenario 2 or 3. In 1990, the net worths of scenario 2 and 3 are, respectively, 12 percent and 8 percent greater than for scenario 1. These differences are about one-third the
differences in 1986. This catching up by scenario 1 is due in part to the failure of farms with lower net worths.

For the conservative farms, there are no failures under any of the price scenarios. The relative ending net worths under the three scenarios are similar to that of the aggressive farms with scenarios 2 and 3 having about 24 percent greater net worths than under price scenario 1.

It is interesting to compare the farm types. Under scenario 1, the ending DTA ratio was nearly .37 for both types of farms, but for the conservative farms under scenarios 2 and 3 the DTA ratios are between 35 percent and 50 percent less than the respective DTA ratios for the aggressive farms. Yet, the ending net worths under the 3 scenarios vary less than 10 percent across farm types.

This implies that the ending net worths under the 3 scenarios are not greatly affected by the debt management policy of the farm but that the DTA ratios are greatly affected by debt management policy. Both survival rates, especially under scenario 1 and ending DTA ratios under scenarios 2 and 3, are affected by debt management.

The results of the 320 acre farm simulations are summarized in Table 14.

As land values decrease, the DTA ratio of the farms increases. If the farms are at or near the desired maximum DTA ratio expansion, investment stops as land prices decrease. All excess funds devoted to reducing the DTA ratio to below the desired maximum. As land prices continue to decrease, the DTA ratio continues to increase and with no capital gains
Table 14. 1976 320 acre farm simulations

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<th>Year</th>
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<th>Total assets</th>
<th>Total debt</th>
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<td>429,810</td>
<td>.450</td>
<td>399</td>
<td>525,324</td>
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from land, only earning returns can be used to lower debt. Without capital gains to be borrowed against, all previous commitments of funds such as taxes, consumption, and interest payments must come from earnings also. If earnings are not large enough to meet these previous commitments of funds they are debt financed, increasing the DTA ratio even further. A note: regardless of the debt management policy initially used by a farm, once the farm is under financial stress, i.e., the DTA ratio is greater than the desired maximum, all the farms use the same strategy to reduce the DTA.

There are two factors that determine whether a farm fails in this simulation model: the extent of the land price decreases and the level of earnings. Scenario 1 is dominated by the land price decrease with land prices falling 60 percent. The result in farm failures, for the farms under the aggressive debt policy, is obvious with the failure rates between five and ten times those for either of the other scenarios. Scenario 2 has lower failure rates than scenario 3, between 30 and 50 percent lower, under the aggressive debt policy due to both its higher level of earnings and higher land prices, which are due in part to the higher levels of income.

Under the conservative debt policy, farm failures are much less prevalent due to the relatively larger reserve of equity available to help ride out the land price decreases. Even though the conservative debt policy farms have lower total net worths in 1981, the peak land price year, the net worth per acre is larger for the conservative debt policy farms, (see Table 15). In 1981, the net worth per acre of the
conservative debt policy farms is between 15 percent and 35 percent larger than their counterpart farms with an aggressive debt policy.

At the end of the simulation, the relative net worth per acre across the different price scenarios reveals something about the effect of the different price scenarios on the financial structure of the farms.

For the conservative debt policy, farms in 1990, price scenario 1 has the lowest net worth per acre, again due to the dominance of land price decreases in scenario 1. For the two 640 acre farm types, the net worths per acre under scenario 2 are approximately 20 percent larger than those under scenario 3. For the 320 acre farm type, the net worth per acre under scenario 3 is five percent larger than for under scenario 2. This is due to the restarting of expansion by the 320 acre farm types.
between 1986 and 1990. Under scenario 2, average size of the 320 acre farm types increases by five percent as opposed to less than one percent for scenarios 1 and 3.

Those increases may be small but they are increases and thus signal the existence of expansion investment by some of the farms. Between 1886 and 1990, when land prices are again increasing, farm sizes continue to decline for all farm types and price scenarios with the aggressive debt policy and decline or remain stable for the 640 acre farm types with the conservative debt policy.

For the aggressive debt policy farms, the ending net worths per acre for scenarios 2 and 3 are less than those for their counterparts with the conservative debt policy, except for the 640 acre moderate debt farm type under scenario 3. For the 640 acre farms, scenario 3 has higher per acre net worths than under scenario 2, and vice versa for the 320 acre farm type. Also, the per acre net worths under scenario 1 are substantially higher than either scenario 2 or 3 for all three farm types. These results are the opposite of those observed under the conservative debt policy. This can be accounted for by the higher rates of farm failures under the aggressive debt policy.

With the continuing downward trend in land prices through the early part of 1985, price scenario 1 would seem to be the best estimate of the future, especially with the pessimistic outlook for federal farm programs to support farm income. Therefore, the results under price scenario 1 are of greater interest and deserve further evaluation.
The range of farm failures is large with between zero and 71 percent of the farms failing in the various runs. Two of the runs had no failures; 1) the 320 acre farm with the conservative debt policy and 2) the 640 acre farm with the conservative debt policy and an initial DTA ratio of .312. The 640 acre farm with the conservative debt policy and an initial DTA ratio .156 had a failure rate of about 6 percent. The remaining three runs under price scenario 1, the three with the aggressive debt policies, had high failure rates of between 25 and 71 percent.

The results for the price scenario 1 runs were re-examined so that yearly averages of various statistics; such as total debt, net worth, and DTA ratios could be compared between those farms that failed before the end of the simulation and those that successfully completed the simulation.

The first and most obvious comparison to make is between the farm that failed and those that did not in the three aggressive debt policy runs. When examining the changes that occur in the various farms, one notices the similarities between the types of farms even though the initial size and levels of debt vary between the three runs.

Changes in the levels of the various types of debt, real estate and nonreal estate, are quite similar. Figures 1, 2 and 3 show the levels of total debt, real estate debt, and nonreal estate debt through time for the three runs. Most noticeable is the rapid rise in both real estate and nonreal estate debt during the first few years of the run, this occurs even when all the farms are at their desired maximum DTA by the end of the first year of the simulation.
Real estate debt begins to level off in 1981 and then starts downward as farmers have stopped purchasing land but continue to pay off real estate debt. The farms that fail increase real estate debt faster than the successful farms and have approximately 20 percent higher real estate debt by 1981. This is due in part to the larger size, in acres, of the farm that will fail, however, the difference in acres is roughly only one-half of the differences between levels of real estate debt. This indicates that the farms that will fail used, on average, a higher level of debt financing for the acquisition of new land.

During the same period, the level of nonreal estate debt for the farms that will fail has been slightly below that of the successful farms, even though the farms that will fail are larger and will thus have larger operating expenses and levels of intermediate assets to finance.

The net affect on total debt is that the farm that will fail with slightly higher, about 5 percent, total debt through 1981. Also, the ratios of real estate to nonreal estate debt has remained fairly constant through this time period at near 1 to 1.

Where real estate debt peaks in 1981 and then starts a steady decline, nonreal estate debt continues to increase until 1984 or 1985 before starting dramatic decreases. The increases in nonreal estate debt more than compensate for decreases in real estate debt after 1981 so that total debt continues to increase until nonreal estate also starts to decrease. The gap in total debt between the successful farms and those that will fail increases to about 10 percent as the farms' that will fail nonreal estate debt becomes larger than that of the successful farms.
Even though land values continue decreasing in 1985 and 1986, the total debt of the successful farms and those that fail decreases. The gap in total debt widens even further to about 20 percent. This decrease in total debt can be explained by the sale of farm assets by the farms. In 1985 the average size of farms starts to decrease as the farms sell off assets to meet fund needs. This selling off of assets does three things, (1) reduces the need for funds in the next period for production expenses, (2) makes the receipts from the sales available for use, and (3) reduces the credit limit of the farm. The third factor, reduced credit limit may force repayment of debt if the new lower credit limit is below the old level of debt, this in turn reduces the receipts available to meet the previous demands for funds.

The successful farms sell off between 25 percent and 45 percent of their land while the farms that fail only sell off between 15 percent and 25 percent of the land. When the sell-offs of assets begin, the average DTA ratios, are between .66 and .71, with these high DTA ratios, repayment of debt must occur to keep the amount of total debt below the credit limit.

The affect of such large scale selling of land on land prices is unknown. These sales, however, are not strictly price related. In the conservative debt policy runs, land reductions are between 0 and 10 percent even though land prices have the same patterns, so it is not so much the change in the price of land that causes sales, but the change in the financial structure of a farm caused by land price changes that induce the sales.
The total assets of the farms that failed started identical to those that succeeded in each run, see Figures 5, 6 and 7, by 1981 the total assets of the farms that fail are between five and ten percent greater than those that succeeded. The difference in net worth between the farms is similar, see Figures 9, 10 and 11, with the farms that fail having net worth of between five and ten percent larger by 1981 than for those farms that succeeded.

At this point, one would be hard pressed to see any reason for one group to fail and the other not to. To see the reason for the farm failures net cash income, NCI, must be examined. Figures 13, 14 and 15 show the levels of net cash income available at the end of a year. Net cash income defined as net operating income after taxes minus cash fixed expenses minus consumption minus interest owed on outstanding debt. This represents the amount of cash funds available for (1) principal repayment, (2) investment in assets, or (3) next year production expenses, and represents a noncapital gains produced increase in the equity of the farm. The distinction in net cash income is quite apparent if the average levels for the period; 1976-1981 and 1982-1987 are compared between farms that failed and ones that succeeded. For the 640 acre farms the average cash income of the failed farms was 40 percent larger for 1976-1981 and 17-25 percent smaller for 1982-1987 than for the farms that succeeded. For the 320 acre farm net cash income for the farms that failed averaged 23 percent greater than for those that succeeded for 1976-1981. For 1982-1987 net cash income for farm that
failed was negative, a 11 percent decrease, while net cash income for the farm that succeeded decreased by only 20 percent.

In all three runs the net cash income of the farms that failed was substantially higher than for those that succeeded, between 1976 and 1981, this in part explains their more rapid growth, during the period when land prices were increasing. During the land price decreases when the capital gains are negative and the cash increases in equity are needed to offset capital losses those that failed had below average net cash income. This is in general since the figures are for the averages, there are certainly specific instances where farms did not follow the general pattern of the typically failed or successful farm due to the stochastic nature of income in the model.

This suggests that not only net cash income during the land price decreases affects survivability but that relative change in net cash income is important. Because if net cash income during the 1976 to 1981 period was not important, then given the stochastic nature of the income levels there should have not been a significant difference between the NCI of successful and failed farms in that period.

The implication of this on the types of farmers, marginal versus efficient, that are in the most danger of failure is important when the long term efficiency of farmers is considered. The model shows that those most in danger of failure are those who had much higher than average returns in the late '70's and early '80's and lower than average returns in the mid to late '80's, it is hard to see where marginally efficient farmers fit this pattern. So the claim that those farmers who
are failing do not deserve to be farmers, are not efficient enough, will be hard to substantiate.

A second comparison that should be made under price scenario 1 is across debt policies for farms of a given size and initial debt. The 640 acre farm with an initial DTA ratio of .312 is interesting because of the large difference in failure rates, under the aggressive debt policy 71 percent of the farms fail and under the conservative debt policy none of the farms failed.

The most noticeable difference is how total debt and nonreal estate debt change through time, see Figures 3 and 4. As stated earlier, under the aggressive debt policy both total debt and nonreal estate increase dramatically until about 1984 then begin to decrease. For the conservative debt policy both total debt and nonreal estate debt increase continually, except in 1977 and 1987, until the end of the simulations. At the start of the two runs, real estate and nonreal estate debt each account for about 50 percent of the total debt. For the aggressive debt policy farms at the end of the simulation, the ratio of nonreal estate to real estate debt is still nearly 1 to 1 after having reached a peak of 2 to 1 in the middle of the simulation. For the conservative debt policy farms, the ratio of nonreal estate to real estate debt also starts at 1 to 1 and then increases to 2 to 1 in the middle of the simulation, but then continues to increase to 3 to 1 by the end of the simulation. Even though nonreal estate debt rises in the conservative debt policy run it never reaches the level of the peak nonreal estate debt under the aggressive debt policy. Real estate debt follows nearly the same pattern
under both debt policies, i.e., a gradual decline until 1978 then rapid
increases until 1981, then gradual decreases the rest of the simulation,
the only major difference is the jump in real estate debt under the
aggressive debt policy in the first year.

Given the similarity of debt patterns in the early part of the
simulations and the similar total asset patterns, see Figures 7 and 8, it
is not surprising that the peak net worths, see Figures 11 and 12, in
1981, differs by less than 5 percent at a level about twice the initial
net worth. The ending net worths of the farms vary greatly. The ending
net worths of the successful farms with the aggressive debt policy are
nearly 40 percent greater than those of the conservative debt policy. It
also should be noted that in 1986 when both land values and net worths
are at the minimum, the average net worths under the aggressive debt
policy of the successful farms is 15 percent less and 30 percent less for
the farms that fail than under the conservative debt run. This indicates
that the relative recovery in net worth by the surviving farms under the
aggressive debt policy is on average greater than for those under the
more conservative debt policy. To check to see the affect of the
stochastic income on the surviving farm under the aggressive debt policy,
the same farms that survived were found under the conservative debt
policy run, this was possible since the same set of stochastic stock
variables was used in each run, and their average DTA ratios and total
assets were found to be less than 3 percent different from the averages
of the whole run. This would indicate that the surviving farms with the
aggressive debt policy did not have much higher than average income
levels but that their patterning of high and low income years within the simulation were better suited for farm survival.

One explanation for the differences in total debt and nonreal estate debt patterns is the difference in the amounts of assets sold. Under the aggressive debt policy, farms between 20 and 30 percent of land is sold with accompanying assets and for the conservative debt policy, about 5 percent is sold. Given that the repayment order in the model when debt repayment is necessary to reduce the total debt below the credit limit is 1) short term debt, 2) intermediate debt, and 3) real estate debt, the decrease in nonreal estate debt in the aggressive debt run is obviously due to forced debt repayment.

Since these two runs start out with identical debt and assets, a comparison of the net cash incomes, NCI, would show the affect of the different debt policies on net cash income, see Figures 15 and 16. During the period 1976-1981, the average NCFI for conservative debt run was $28,494 per year, nearly identical to $28,618 per year for the farms that will fail in the aggressive debt policy run but 40 percent larger than the $20,139 per year average for the successful farms under the aggressive debt policy.

During the 1982 through 1987 period, the average NCFI for conservative debt policy farms is $36,703 per year which is 2.8 times as large as the $13,084 per year for the farm that fail and 1.8 times as large as the $20,179 per year for the farms that succeeded under the aggressive debt policy. The average for 1976-1987 are $32,225, $21,561, and $20,457 per year for the conservative debt policy, failed farms and successful farms.
under the aggressive debt policy respectively. There is only a 5 percent
difference over the eleven years between the failed and successful farms
under the aggressive debt policy, which are over 30 percent less than for
the conservative debt policy farms.

The 15 year average for the successful farms under the aggressive
debt policy is $23,448, 30 percent less than the $33,792 15 year average
for conservative debt policy farms.

The choice of debt policy affects the general level of net cash
income as evidenced by the large differences in NCFI between the two
runs. This in turn affects the general risk of farm failure, zero
percent failures versus 71 percent failures for the long runs. However,
the patterning of NCI levels with respect to changes in land prices is of
major importance in determining which farms fail at a given level of
income. Note the similarity of the 11 year averages in the aggressive
debt policy run and the dissimilarities between the two period averages.

Summary of Results

1964 runs

The simulation model showed that the 160 acre farms were unable to
generate sufficient returns to meet the consumption and other cash
demands of the farms. The cash out-flow forced the use of debt financing
for production expenses, which in turn increased cash out-flows by
increasing interest and principal payment obligations. Even though net
worths of the farms were increasing, due to capital gains, the farms were
unable to meet cash outflows.
The 320 acre farms were able to generate sufficient funds to meet cash demands without having to increase DTA ratios. Increases in DTA ratios were observed to have large positive effects on the size and net worths of the farms.

The 640 acre farms generated more than sufficient funds to meet cash demands and were able to use the excess funds along with increases in DTA ratios for expansion allowing for very rapid rates of expansion.

1976 runs

The results of the 1976 runs revealed the influence of both debt management policies and price scenarios on farm failure risk and expansion potential. The choice of debt management policy by farmers had a significant effect on farm failure rates and this in turn affected the relative financial conditions of the surviving farms under the different price scenarios.

The effects of the price scenarios on the financial structure of the farms is best seen under the conservative debt policy, where the effects of different levels of farm failure does not distort the relative ending financial conditions.

Under price scenario 1, low farm income and high real interest rates, the risk of farm failures under the aggressive debt policy is four to five times as large for the 640 acre farms and two and one-half times as large for the 320 acre farms as for the other price scenarios.

Under price scenario 1 with the conservative debt policy farms facing risks of farm failure similar to those of the other price scenarios, yet they have noticeably higher DTA ratios and lower net
worths. Within a run, the main difference between the successful and the
failed farms is the distribution of net cash income through the run. The
average level of net cash income for the entire simulation varied little
between successful and failed farms. However, there were significant
differences between the net cash income levels of the successful and
failed farms in both the periods of increasing and decreasing land
prices, with the failed farms having higher average levels of net cash
income during the period of increasing land prices and lower average
levels during the period of decreasing land prices, as compared to the
successful farms.

The differences between runs in average levels of net cash income
showed up in the probability of failure in the various runs, with the
conservative debt policy runs having higher levels of net cash income,
due to lower interest payments, and lower failure rates than their
counterpart aggressive debt policy runs.
Figure 1. Total debt, real estate debt, and nonreal estate debt for 1976, 320 acre farm simulations with an aggressive debt policy.
Figure 2. Total debt, real estate debt, and nonreal estate debt for 1976, 640 acre farm simulations with 0.158 initial DTA ratios with an aggressive debt policy.
Figure 3. Total debt, real estate debt, and nonreal estate debt for 1976, 640 acre farm simulations with .376 initial DTA ratios with an aggressive debt policy.
Figure 4. Total debt, real estate debt, and nonreal estate debt for 1976, 640 acre farm simulations with .316 initial DTA ratios with a conservative debt policy.
Figure 5. Total assets for 1976, 320 acre farm simulations with an aggressive debt policy.
Figure 6. Total assets for 1976, 640 acre farm simulations with .158 initial DTA ratios with an aggressive debt policy.
Figure 7. Total assets for 1976, 640 acre farm simulations with .376 initial DTA ratios with an aggressive debt policy
Figure 8. Total assets for 1976, 640 acre farm simulations with .316 initial DTA ratios with a conservative debt policy.
Figure 9. Net worth for 1976, 320 acre farm simulations with an aggressive debt policy.
Figure 10. Net worth for 1976, 640 acre farm simulations with .158 initial DTA ratios with an aggressive debt policy.
Figure 11. Net worth for 1976, 640 acre farm simulations with .376 initial DTA ratios with an aggressive debt policy.
Figure 12. Net worth for 1976, 640 acre farm simulations with .316 initial DTA ratios with a conservative debt policy
Figure 13. Net cash income for 1976, 320 acre farm simulations with an aggressive debt policy.
Figure 14. Net cash income for 1976, 640 acre farm simulations with .158 initial DTA ratios with an aggressive debt policy.
Figure 15. Net cash income for 1976, 640 acre farm simulations with .376 initial DTA ratios with an aggressive debt policy.
Figure 16. Net cash income for 1976, 640 acre farm simulations with .316 initial DTA ratios with a conservative debt policy
CHAPTER 6. CONCLUSIONS

The choice of debt management strategy by farmers plays an important role in determining the returns to owning land, as measured through the change in net worth of the operation.

Significant portions of the returns during the period 1964-1981 were due to capital gains especially on land. These capital gains could only be used to expand the operation by debt financing using the increased value of previously held land as collateral.

During the 1964-1978 period, the returns to borrowing were high even at high levels of debt. For example, in 320 acres, farms with approximately a .24 DTA ratio had an increase in net worth of 375 percent from 1964-1978. While farms that increased their DTA ratio from .24 to .36, experienced an increase in net worth of 620 percent for the same period. This implies that the increase in debt level provided an increase in net worth of 245 percent of the 1964 level for the period 1964 through 1976.

During the period 1976 through 1981, this high return to debt seems to have tapered off, especially at higher levels of debt. For example, in the 640 acre farm with an initial DTA ratio of .316 when the DTA ratio was increased by .08 the increase in net worth was only 2 to 3 percent larger than if the DTA ratio was decreased by .04. This decrease return to having debt can be attributed to the higher interest rates experienced in this later time period.

The higher returns to debt in the earlier time period may have more than offset the increased risks from land price volatility. However,
during the 1970s and early 1980s debt financing of land purchases became increasingly less profitable even though land prices were continuing to rise. When the land prices started their decline, farmers who had not lowered debt levels to match the decreased returns to debt had in effect lowered their returns without lowering risk from land price movement.

This can be shown in the hypothetical price scenarios. Under scenarios 2 and 3, interest rates are at lower levels than under scenario 1 implying relatively higher, although still possibly negative, returns to holding debt. The effect of this on ending net worths and farm failure rates is quite evident even on farms with relatively low levels of debt in 1981, the 320 acre farm with the conservative debt policy is the best example.

The farms that failed simply reached the limit of their credit. By increasing their debt to such high levels, most farms that failed had DTA ratios of over .70, the sale of assets, especially land when prices were decreasing, did not bring in many new funds. This was due to the fact that at these high levels of DTA ratios the sale of assets reduced the credit limit below the level of debt and forced the repayment of debt out of the sale revenues thus lowering the amount available to meet the needed funds that caused the sale in the first place.

The use of debt by farmers is not without risk, as evidenced by the effect of debt management policy on farm failure rates in the simulations. Some analysis of the returns to using debt is necessary so that the relative risk of using different levels of debt can be weighed against their returns. A discussion of the risk preferences of farmers
is offered here. Antle (1983) showed the importance of risk in dynamic production relationships regardless of the risk preference of the operators.

One measure of the returns to using debt is to compare the increase in net worth to the increase in debt over a period to time. In the 1964 runs the 320 acre farms show a variety of responses to changes in debt levels and DTA ratio. Run 5, the low debt farm, had the largest increase in net worths relative to its increase in debt level, nearly a 6 to 1 ratio. Run 3, the aggressive debt policy, has an increase in DTA ratio similar to that in run 5, yet has only 1.67 to 1 ratio of increase in net worth to increase in debt with a total increase in debt of nearly 4 times that of run 5.

Run 4, the conservative debt policy, maintains nearly the same DTA ratio even though its level of debt increases by 420 percent. Run 4's ratio of increase in net worth to increase in total debt is 3 to 1, between that of runs 3 and 5.

There appear to be decreasing returns to using debt, as measured by change in net worth ratio, over both DTA ratio and debt levels. In comparing runs 3 and 4, the marginal increase in net worth to increase in debt for an increase in DTA ratio is 1 to 1 only one-third that of run 4. In comparing run 3 and the effect of the same change in DTA ratios on farms with different internal DTA ratios is observable. Run 5 has 90 percent of the increase in net worth with only 25 percent of the increase in debt of run 3, that relatively nearly the same return for increases in DTA ratios are available at both high and low initial DTA ratios, but it
should also be noted that the risk incurred, measured by future fixed debt repayments, to receive those returns are much higher for the farms with the higher initial DTA ratios.

For the period 1976-1981, the different farm types and debt management policies have a wide range in change in net worth per change in debt, from 78 to 3.55. In all three farm types, the increase in net worth per increase in debt is much greater for the conservative debt policy runs than for their counterpart runs under the aggressive debt policy between 1.8 and 3.6 times as large, even though the aggressive debt policy runs have much larger increases in debt levels.

Since the only difference between the conservative and aggressive debt policy runs, within a farm type, is desired maximum DTA ratio of the farms, the increases in net worth and debt of the conservative debt policy farms can be subtracted from the increases in net worth and debt respectively, of the aggressive debt policy runs to determine the increases in net worth due to the marginal increase of debt by the aggressive debt policy runs over that of the conservative debt policy runs. Table 16 presents information regarding changes in net worth and debt of the 1976 runs.

The marginal returns to increased, measured by changes in net worth, of the aggressive debt policy over the conservative debt policy are very small, between 2 and 15 percent of the returns for the conservative runs. This would seem to be a very small return given the fact the marginal increases in debt not only have the same repayment demands as the debt

<table>
<thead>
<tr>
<th>Debt policy</th>
<th>640 acre high debt</th>
<th>320 acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase in net worth</td>
<td>643,056</td>
<td>$593,513</td>
</tr>
<tr>
<td>Increase in debt</td>
<td>424,246</td>
<td>$167,009</td>
</tr>
<tr>
<td>Ratio</td>
<td>1.52</td>
<td>3.55</td>
</tr>
<tr>
<td>Aggressive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase in net worth</td>
<td>760,488</td>
<td>613,430</td>
</tr>
<tr>
<td>Increase in debt</td>
<td>899,174</td>
<td>538,333</td>
</tr>
<tr>
<td>Ratio</td>
<td>0.85</td>
<td>1.14</td>
</tr>
<tr>
<td>Marginal of aggressive over conservative</td>
<td>$117,432</td>
<td>19,917</td>
</tr>
<tr>
<td>Increase in net worth</td>
<td>$474,928</td>
<td>371,324</td>
</tr>
<tr>
<td>Increase in debt</td>
<td>372,513</td>
<td>167,009</td>
</tr>
<tr>
<td>Ratio</td>
<td>.24</td>
<td>0.05</td>
</tr>
</tbody>
</table>

incurred by the conservative debt policy runs but they also increase the DTA ratio of the entire farm.

The ratio of increase in net worth to increase in debt is important in that for a given interest rate on debt it is possible to calculate the needed rate of return on the new assets, the increase in net worth plus the increase in debt, necessary to meet just the interest payments on the new debt. The necessary rate of return is derived from the equation

\[
r = \frac{i}{1+E}
\]

where

\[
r = \text{rate of return necessary to meet interest payments},
\]

\[
i = \text{interest rate on debt}, \quad \text{and}
\]

\[
E = \text{increase in net worth per increase in debt}.
\]
Table 17 presents for a range of Es the necessary rate of returns as a percent of the interest rate.

For the period 1976 through 1981, the necessary rates of return as a percent of the interest rate on new assets to meet interest payments on new debt ranged from 22 percent to 40 percent for the conservative runs and from 46 percent to 56 percent for the aggressive runs. However, for the aggressive debt policy runs if the farmers expected the marginal assets of the aggressive over the conservative debt policy to make the interest payments on the marginal debt the necessary rates of return would have to be between 80 percent and 95 percent of the interest rates on debt.

An alternative approach to examining the rates of return on assets, which are based on asset values and would be affected by changes in land values, would be to calculate returns per acre and from that devise a maximum sustainable debt level per acre based on expected interest rates and future income levels.

The highest level of sustainable debt per acre would be equal to the returns per acre divided by the interest rate on debt. This would give the maximum debt level on which the returns would meet interest payments. With uncertainty for both future interest rates and income levels there would be a degree of uncertainty about the maximum sustainable debt level.

With uncertainty about maximum sustainable levels of debt the farmer's risk of being unable to meet interest payments is affected by the chosen debt level. If the farmer is unable to meet interest
Table 17. Necessary rates of return to meet interest payments as a percent of the interest rate

<table>
<thead>
<tr>
<th>E</th>
<th>r (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5</td>
<td>22</td>
</tr>
<tr>
<td>3.0</td>
<td>25</td>
</tr>
<tr>
<td>2.5</td>
<td>29</td>
</tr>
<tr>
<td>2.0</td>
<td>33</td>
</tr>
<tr>
<td>1.5</td>
<td>40</td>
</tr>
<tr>
<td>1.0</td>
<td>50</td>
</tr>
<tr>
<td>.5</td>
<td>67</td>
</tr>
<tr>
<td>.05</td>
<td>95</td>
</tr>
</tbody>
</table>

payments, then either assets must be sold to meet them or the interest payments must be debt financed. One way to avoid this would be for the farmer to choose a debt level; given the distribution of maximum sustainable debt, such that there is only small probability, i.e., 5 or 10 percent, that the actual maximum sustainable debt will be lower than the chosen debt level.

Since most farmers not only want to make the interest payments on their debt they also desire to reduce the level of debt by making principal payments, maximum sustainable debt and necessary rate of return should probably be recalculated to include some level of principal payments.

Conversely the maximum sustainable debt level is the concept of necessary returns per acre. For given levels of debt, interest rates, and principal repayments, a level of returns per acre can be calculated that is necessary to meet these criteria and this can be compared against
the distribution of expected income levels to determine the probability of being unable to meet desired interest and principal payments.

For the 1976 640 acre farm with moderate initial debt, there are noticeable differences in the returns per acre between the successful and failed farms in both the period of increasing land prices, 1976-1981, and decreasing land prices, 1982-1987. For the aggressive debt policy run, there is little difference in necessary returns per acre to meet interest payments, but due to the high DTA ratios under the aggressive debt policy the small difference in returns makes a large difference in the ability of the farms to meet debt payments. For the failed farms under the aggressive debt policy during 1982 through 1987, the needed returns to meet interest payments were equal to 100 percent of actual returns so that even though interest payments could be met there were no funds available for principal payments. For the conservative policy run, there are differences in the needed returns, this is probably due to the low level of failures and the fact that those few farms that failed were further away from the norms than under the aggressive debt policy. Table 18 presents averages for returns, needed returns, and the ratios of needed returns to returns for the 1976, 640 acre farms with moderate initial debt.

The model shows decreasing returns to debt in both the 1964 and 1976 simulations, while risk due to debt increased at least proportionately if not faster due to the effect of both increases in debt levels, which increases fixed financing costs, and increases in DTA ratios which lowers
Table 18. 1976 640 acre farms with .158 initial DTA ratios

<table>
<thead>
<tr>
<th></th>
<th>Aggressive debt policy</th>
<th>Conservative debt policy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Successful farms</td>
<td>Failed farms</td>
</tr>
<tr>
<td>Average returns per acre</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1982-1987</td>
<td>156</td>
<td>141</td>
</tr>
<tr>
<td></td>
<td>$102</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>147</td>
<td>132</td>
</tr>
<tr>
<td>Average needed returns per acre</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1976-1981</td>
<td>$80</td>
<td>79</td>
</tr>
<tr>
<td>1982-1987</td>
<td>130</td>
<td>132</td>
</tr>
<tr>
<td></td>
<td>$56</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>96</td>
<td>112</td>
</tr>
<tr>
<td>Ratio of average returns per acre to average needed returns/acre</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1976-1981</td>
<td>.74</td>
<td>.66</td>
</tr>
<tr>
<td>1982-1987</td>
<td>.85</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>.54</td>
<td>.57</td>
</tr>
<tr>
<td></td>
<td>.65</td>
<td>.93</td>
</tr>
</tbody>
</table>

the relative size of the equity reserve as compared to the amount of debt.

Debt management policy played an important role in determining the rate of failures in a simulation. The aggressive debt management policy had higher rates of failure than the conservative debt management policy had even when the aggressive debt policy run had a higher level of income than the conservative run, i.e., compare the aggressive debt policy under price scenario 2 to the conservative debt policy under price scenario 1.

Restating again, the most important determinate with a run of which farms failed was the distribution of income through time for a particular farm, not so much the farm's overall level of income.
REFERENCES


Iowa State University. Farm Business Summaries. Cooperative Extension Service, various years.


APPENDIX. FARM MODEL

There are 13 procedures within the farm model program. These procedures conduct various financial transactions for the farm such as, calculating returns, depreciating and appreciating assets, buying or selling of assets, and checking for solvency.

The MAIN program contains the initial financial and physical description of the farm, financial restrictions, loan terms, and indexes for asset values, interest rates, and general prices. MAIN calls the procedure TEST.

TEST calculates the returns, expenses, and changes in asset values for the farm for a year of operation. TEST then determines if the farm meets certain minimum financial requirements. If so, IA is called and if not, SELL is called. SELL calls END after the desired number of production cycles.

IA determines if intermediate assets must be purchased to maintain proper asset ratios given depreciation of intermediate assets. If intermediate assets must be purchased, BUY-IA is called, otherwise YTCE is called.

BUY-IA purchases the required intermediate assets if funds are available and then calls YTCE; if not enough funds are available, SELL is called.

YTCE calculates the needed funds to meet the next year's production expenses. If the funds are available, they are set aside and INVEST is called. If funds are not available, SELL is called.
INVEST checks for a willingness for expansion investment by the farm. If the farm is not willing to expand NEXTYEAR is called. If expansion investment is desired, available funds are divided between asset types. Then, if enough funds are available to purchase an 80 acre unit of land and the needed current and intermediate assets to maintain proper asset ratios, then all three types of assets are purchased. If not enough funds are available to purchase land, only intermediate assets are purchased, and the rest of the funds are used to either reduce debt or are saved. If so, then NEXTYEAR is called.

SELL determines needed funds for the next production cycle both to maintain asset ratios and to meet production expenses. If the sale of 160 acres of land plus accompanying current and intermediate assets will not meet needed production expenses for the next year, the farm is declared insolvent and BANKRUPT is called. SELL determines what assets to sell. First, any intermediate assets over the minimum necessary for the size of the farm are sold. Then, land is sold in 80 acre increments along with excess current and intermediate asset over the desired ratios by either calling LAND-ONLY and/or LAND-PLUS. Excess funds due to the lumpiness of land sales is used to reduce debt. If so, then NEXTYEAR is called.

NEXTYEAR calculates end of year statistics and resets variables for the next production cycle and then returns to MAIN.

BANKRUPT tabulates current year statistics and calls END. END prints out a report of yearly statistics and terminates the run.
Two other procedures are used, BORROW and REPAY. They are called by various procedures to change the level debt as needed to reflect increased borrowing or repayment of debt.