1983

The impact of financial constraints on the local price of farm land

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THE IMPACT OF FINANCIAL CONSTRAINTS ON THE LOCAL PRICE OF
FARM LAND

Iowa State University

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300 N. Zeeb Road, Ann Arbor, MI 48106
The impact of financial constraints on the local price of farm land

by

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A Dissertation Submitted to the Graduate Faculty in Partial Fulfillment of the Requirements for the Degree of DOCTOR OF PHILOSOPHY

Major: Economics

Approved:

Signature was redacted for privacy.

In Charge of Major Work

Signature was redacted for privacy.

For the Major Department

Signature was redacted for privacy.

For the Graduate College

Iowa State University
Ames, Iowa
1983
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CHAPTER I. INTRODUCTION

Land is a major input into agricultural production and a major asset to many producers. Because land purchase invariably involves debt financing, land contract or mortgage debt similarly appears as a major liability on many producers' balance sheets. The dramatic increase in land prices over the last 10 years has had, in fact, a significant impact on both sides of the balance sheet. To owners of land, the price increases have led to an increase in their asset values and net worths. To would-be owners, the price increases have either thwarted their attempts to purchase land or have forced them to finance, through debt, an increasingly larger proportion of the value of the land they have been able to purchase.

The growth in the use of land contracts with their traditionally smaller down-payment requirements has facilitated this rise in leverage. Another factor that has, at least potentially, contributed to the rise in leverage is the provision of the Farm Credit Act of 1971 that allowed the Federal Land Bank to make loans of up to 85 percent of the market value rather than 65 percent of the normal agricultural value of farm land. Since, in times of rising prices, market values typically exceed normal agricultural value, the provision substantially increased the potential availability of debt financing through Federal Land Bank mortgages. It was assumed that the liberalization of down-payment terms would allow FLB lenders more discretion in making loans and that young,

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1Normal agricultural value reflects appraised value.
low-equity farmers might have better access to real estate credit. Whether this has, in fact, occurred, is subject to empirical verification, but equally important is the contention that liberalized down-payment terms have an impact on the price of farm land.

The latter hypothesis, roughly stated, is that higher loan-to-value ratios in land purchases have resulted in higher land prices. Lower down-payment requirements can increase both the number of qualified buyers and the leveraging power of existing equity, thus increasing the effective demand for farm land. The extent to which this might occur would depend not only on the willingness of lenders to lend at higher loan-to-value ratios, but also on the willingness of buyers to borrow proportionately larger sums to purchase land. Borrowers may be assumed to contemplate an optimal level of loan-to-value in land purchase that exists independently of lender imposed limits. This optimum is a function of a number of factors with the borrower's initial wealth position and his regard for risk being foremost among them. In the case of farm borrowing, the age of the borrower is often deemed important. Younger farmers typically have less equity than older farmers. Farm businesses, especially sole proprietorships, may follow a "life cycle" in which the first stage of the cycle is accompanied by heavy borrowing and succeeding stages by debt repayment and rising equity. Regardless of the age of the farmer, his decision to acquire assets is made not only in reference to an optimal set of assets, but to an optimal mixture of debt and equity as well. This debt-equity mix determines the financial structure of the borrower's operation.
It is the purpose of this study to examine the effect of the interrelationship between farm financial structure and mortgage and contract down-payment terms on the price and ownership of agricultural land. The study will focus on the behavior of the farm decision maker, both as a demander of land and as a demander of debt financing.

An important assumption will be employed and developed throughout the course of the study. Decision makers will be assumed to be constrained in investment and production decisions by limited money capital. Money capital is differentiated here from real or physical capital. It is not a productive asset such as land or labor; in fact, in an accounting sense, it consists of the farm firm's liabilities and net worth. Its availability, however, imposes a constraint on the purchase of real assets. The importance of this assumption is that the conditions under which money capital is made available to a decision maker can have an impact on input selection.

Demand functions for inputs, as typically derived from profit maximization equations, do not reflect the impact of money capital scarcity or the desired financial structure. Most firms, be they sole proprietorships, partnerships, or corporations, face some type of money capital constraint. Sole proprietors do not possess unlimited equity, nor do corporations face perfectly elastic equity supply curves. The supply of debt capital to a firm can similarly become sharply inelastic at higher debt/equity ratios. The constraint, however, is not necessarily imposed externally, but may instead be internal to the firm. The equity employed in a particular investment or in total may be less
than that potentially available. Likewise, for a given level of equity, the amount of debt capital used may be far less than that available at no significant increase in cost. The degree to which these constraints impinge on the input and output decisions of the firm is not captured in the standard model of firm behavior. A complete model of firm behavior would examine not only the production decisions, but also the level of capital investment and the method of financing that investment.

As noted earlier, the particular interest of this study is the development of such a model to explain the demand and thus, the price paid for agricultural land within the context of both money capital scarcity and farm financial structure. In pursuing optimality in financial structure, as well as in output level and input mix, the decision maker will find that developments in the debt market can influence both the total asset value of his operation and the composition of those assets. The model of decision maker behavior that will be developed will examine the demand for productive inputs under the condition of an exogenously determined debt level. While this formulation may lose some of the detail that would be present if total debt were a decision variable, it does recognize the fact that many land market transactions are impeded by the lack of availability of external financing. Furthermore, even when the total debt decision is endogenous to the firm, it may be made prior to the input employment decision rather than simultaneously with it. A firm could select a debt-equity combination that minimizes its cost of capital, thus optimizing its leverage decision and then make its production decisions based on its
predetermined cost of capital. Therefore, treating the debt level as exogenous in no way invalidates the contention that financial structure and input choice are interrelated.

Because land price is influenced by supply as well as demand, assumptions will be made about the conditions under which farm land is made available for sale. Given the model of decision maker behavior and the assumptions about land supply, hypotheses about the impact of down-payment terms on the ownership and price of farm land can be made and tested.

Chapter II presents a review of the relevant literature. This review is meant to be representative, not exhaustive. It considers the results of research on the determinants of farm land values, the impact of buyer characteristics on land bid prices and the demand for farm mortgage debt. It also considers previous studies of firm behavior in the presence of money capital scarcity.

Chapter III examines the theoretical basis for firm behavior under money capital scarcity. A specific model is presented and comparative static results are derived.

Chapter IV follows with a brief discussion of the data set used in the empirical analysis. This chapter includes a discussion of how problems with the data set are handled and how further data needs may be met.

The specification of the empirical model, along with a discussion of the statistics, and a summary of the research are the subjects of Chapters V and VI, respectively. The latter chapter also suggests limitations of the present research and areas of future inquiry.
CHAPTER II. REVIEW OF LITERATURE

The relevant literature for an investigation of the relationship between financing and land prices can be grouped into three distinct categories. First is the literature that deals with factors affecting land values. Within this category are studies that attempt to pinpoint the major variables influencing land values, as well as studies that infer the value of farm land from the willingness and ability of buyers to pay. These studies bear examination because they suggest a role for both financial structure and down-payment terms in the determination of land values. The second category of relevant literature includes studies that deal more specifically with the market and the demand for mortgage credit. These studies center on the role of credit terms in the demand for both mortgage credit itself and on the demand for land. The third and final category of relevant literature deals not specifically with the demand for land and mortgage debt, but with the theoretical links between decisions on output level, input mix, and financial structure.

The Impact of Financial Variables on Land Values

Reynolds and Timmons [1969] examine factors affecting farm land values in the United States. The authors propose that credit availability, by affecting entry into and exit from farming, can also affect the price paid for farm land. They note that the price of farm land and the value of farm land, while equal under conditions of pure competition, may not be equal under actual circumstances encountered in the land market. They define value as an estimate of the worth of a
tract of land in the minds of buyers and sellers in a theoretical analysis and as an estimate of price in the empirical analysis [Reynolds and Timmons, 1969, p. 331]. Demand for land is defined as the sum of the various direct and derived demands for land, and supply of land is defined as that amount available for use at any given time as reflected in the number of farm land transfers.

Low cash reserves and high down-payment requirements inhibit the demand for land, while low-equity financing can add to demand. The impact of credit availability, therefore, on the price of farm land is hypothesized to be positive. The more freely available is credit, other things being equal, the higher the price of farm land.

The models estimated by Reynolds and Timmons include both a time-series model for the years 1933 to 1965 and cross-sectional models for the years 1940, 1950, 1954, and 1959. The time-series model consisted of two equations for the U.S. as a whole; the first equation defining farm land transfers and the second equation, farm land value. The predicted number of transfers enter the second equation as an independent variable. Variables representing financing terms for farm land purchases never enter the time-series equation, although the ratio of farm mortgage debt to total equity is included in the equation estimating the number of farm transfers. The impact of this debt-to-equity ratio on transfers is negative and the authors reason that a weakening debt position, as reflected in an increasing debt-to-equity ratio, reduces the ability of farmers to purchase land, thus reducing the number of potential buyers and the number of farm transfers. The debt-to-equity ratio also
appears in the reduced form time-series equation estimating farm land value. The sign of the variable is positive. The explanation is that the rise in the debt-to-equity ratio, reflecting a poor debt position, is coincident with tighter credit which, in turn, reduces the number of farm land transfers and increases the price of farm land.

The cross-section equation is estimated across states. Since the debt-to-equity ratio is not available on a state-by-state basis, the variable, debt-to-value-of-farm-land is used instead. Unlike the time-series case in which an increasing debt-to-equity ratio represents, over time, a worsening of the debt position, the increasing debt-to-farm-land value ratio in the cross-section case is believed to indicate greater availability of credit and a higher rate of voluntary farm land transfers. Since the impact of voluntary transfers on land value is negative, the ultimate affect of an increase in the debt-to-value ratio on land values is also reasoned to be negative.

In all cases, the signs of the finance-related variables are as hypothesized and the variables themselves are deemed statistically significant. Despite this, Reynolds and Timmons shed little light on the impact of farm financial structure or down-payment terms on current farm land prices. In the case of the time-series model, they appear to be capturing some financial structure effect by relating total mortgage debt to total equity to the number of voluntary transfers, while in the cross-section study, the variable included more closely resembles a measure of down payment. In periods of rapid farm land price increases, both variables would seem to be positively related to variation in farm land
values. Other problems, mentioned by the authors, create further difficulty with the estimates. The data used for the analysis are too highly aggregated to effectively isolate the impact of farm financial structure. Furthermore, multicollinearity reduces the efficacy of the estimated coefficients regardless of their having the "correct" signs.

In a test specifically designed to reveal the impact of finance terms on farm land values, Herr [1975] presents an econometric model of the farm land market. His model consists of a single equation which includes three sets of variables. The first set of variables describes the characteristics of the tract of land, the second set describes the characteristics of the buyer and seller, and the third set describes the characteristics of the finance terms. Among the variables describing the individual tract are tract productivity and the percentage of the tract that is cultivable. The second group of variables includes the reasons for buying and selling, respectively. The purchase of land for nonagricultural uses is expected to buoy the price of land, while sales made for the purpose of settling estates or providing emergency cash are expected to depress prices. The variables describing financial characteristics are the ratio of loan to present market value of security, the percentage of purchase price financed, the term of loan, and the ratio of acres appraised to acres in the sale tract.

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1In a study by Pope et al. [1979], a reestimation of the Reynolds and Timmons equations using data for the years 1946 to 1972 yields a positive coefficient for the debt-to-equity ratio in the time-series transfer equation.
Herr's hypothesis regarding finance terms is that they have no added or separate impact on price. They are viewed as either hastening or slowing adjustments that would have taken place anyway. The real cause of price increases is the divergence between the return to land and the market rate of interest on loans to finance the purchase of land. As long as the former exceeds the latter, excess demand for land will tend to push its price upward. To the extent that liberal loan terms, such as low down payments and longer amortization periods allow more buyers to enter the market for land, the adjustment in prices will be hastened [Herr, 1975, pp. 153-154].

The cross-sectional statistical model was estimated twice for each of two groups of sample data, actual farm sales in Iowa and actual farm sales in South Dakota. In the first estimate, only the land characteristic and buyer-seller characteristic variables were included. In the second estimate, the finance variables were added. The conclusion drawn from the estimations was that the finance variables have no separate impact on the selling price of farm land in either the Iowa or South Dakota cases. Only one of the finance variables in one of the equations proved statistically significant.

Herr's analysis is ultimately unsatisfying if only for the fact that it explains so little (about one-half) of the total variation in purchase price per acre. In addition, however, the author would have done well to keep in mind the distinction between land value as a theoretical concept and land price as an observable fact. While economic theory may suggest that land value would not be influenced,
under competitive conditions, by finance terms, land prices, which in an imperfect world diverge from land values, may well be affected by terms such as the down-payment percentage and the term of the loan. Herr recognizes this in saying that changes in finance terms may speed or retard adjustments in the land market. The change in the rate of adjustment would presumably be reflected in actual sale prices.

Lee and Rask [1976] take an innovative approach to the study of land price determination. They propose to look at the land purchase decision within the context of a capital-budgeting problem. The study does not attempt to test the significance of variables determining land values. Instead, it suggests a method by which researchers may determine the maximum bid price a buyer could offer for a tract of land. The variables shown to be relevant to this bid price decision might be used in a study of actual land sales.

The authors argue that the traditional income valuation approach to valuing land may be inapplicable in most cases because it assumes a constant net annual rent over time, a constant capitalization rate to discount earnings and a very long time horizon. Their model includes, as key variables, income expectations and the decision maker's opportunity cost of capital. The standard capital budgeting criterion applies to the model. The purchase of farm land is an acceptable investment if its net present value is equal to or greater than zero. The credit terms included in the formulation are the proportion of purchase price paid down, the nominal rate of interest charged on the loan, and the amortization period of the loan. The authors find that
the financing terms seem to be of some importance in determining the bid price an individual would be willing to make on land. A high down-payment requirement, in particular, results in a lowering of the maximum bid price. Assuming an interest rate on a first mortgage of 10 percent per annum, an individual able to fully lever the land purchase can afford to pay $1,262 per acre compared to $964 per acre for the buyer who, ceteris paribus, pays cash. As noted by the authors, this leverage affect will occur only if the opportunity cost of capital exceeds the after-tax rate of interest on the mortgage [Lee and Rask, 1976, p. 987]. The opportunity cost of capital is likewise an important determinant in the maximum bid price. As the cost of capital rises, the maximum bid price is shown to fall. The cost of capital reflects, in the capital budgeting context, the return on an asset necessary to justify raising the funds to purchase it [Lewellen, 1969, p. 6]. As the necessary return rises, other things being equal, the affordable price of the asset falls.

Through the use of the capital budgeting procedure, Lee and Rask make explicit the link between firm financial structure and demand for assets. It is the presence of the cost of capital in the formulation that creates this link. The cost of capital, itself influenced by the financial structure of the firm, in turn, has an impact on the maximum bid price for farm land.

The determination of the maximum bid price on agricultural land was also the object of an earlier paper by Harris and Nehring [1976]. Their model included several variables of relevance to the present study. One of these was the variability in before-tax income as measured by the
variance of before-tax income. Since this variance is a reflection of risk, both business and financial, and since financial risk is directly related to leverage, the level of the variance in before-tax income is influenced by the degree of financial leverage. Furthermore, given the positive relationship between financial leverage and the cost of capital, a rise in the cost of capital may be assumed to reflect increased risk. Given the negative impact of variance on bid price, a rise in the cost of capital can be said to lower the maximum bid price, a result wholly consistent with Lee and Rask.

The second explanatory variable of interest was the initial wealth level of the decision maker. The authors' hypothesis with respect to this variable was that an increase, ceteris paribus, in the initial wealth position would result in a higher maximum bid price if the decision maker were decreasingly risk averse over wealth. A lower maximum bid price would result if the decision maker were increasingly risk averse, but with a constant degree of risk aversion, a change in the initial wealth position would have no impact [Harris and Nehring, 1976, p. 163].

A numerical illustration was provided to test the bid price model. The average equity of Iowa cash grain farms was calculated for each size category, 0 through IV, category 0 being the largest in terms of number of acres. A measure of risk aversion, necessary for the numerical illustration, was also calculated under the assumption of decreasing risk aversion over wealth. The result of the illustration was that the level of initial equity was shown to have a positive impact on the maximum bid price for farm land. Given the bid price of any particular
size category of farm, the bid price of a decision maker whose operation had all the characteristics of that particular size category, except a lower initial equity, was consistently smaller. An important conclusion of the study was that the impacts of other variables, not discussed here, mitigated, to some extent, the bidding advantage enjoyed by high-equity operators.

One other study is of interest at this point. Reinsel [1973] questioned whether the growth in seller financing of land has tended to increase land prices. Seller contract financing typically requires a smaller down payment than mortgage financing so that any impact that increased seller financing has had might also apply to the liberalization of mortgage lending terms.

Reinsel reasoned that since the seller is really interested in the after-tax present value of the contract, price is only one of the relevant variables. Financing terms including interest rate, down-payment percentage and amortization period, as well as the seller's discount rate, can also influence present value. Thus, varying combinations of price and financing terms can yield the same after-tax present value.

Differences in the terms of mortgage versus contract sale arise from the differential tax treatment of the two. Capital gains on land contract sales can be distributed over the life of the contract as long as the down payment is less than 30 percent of the purchase price. This tax advantage results in the interest rate on contracts generally being lower than that on mortgages. If this has, in fact, been the case and assuming that lower interest rates require a higher price to maintain a
constant present value, then the use of seller financing may have resulted in prices being higher than they otherwise would have been.

Reinsel has no hard evidence of the impact of seller financing. He states that if it is assumed that the discount rate on future principal and interest payments are approximately equal to the mortgage rate of interest then selling price does indeed increase with seller financing.¹ Employing the model he has developed and assuming that the market rate of interest on seller contracts is as much as 1.5 percentage points below the rate for mortgages, then the existence of seller financing may have raised land prices by as much as 10 percent.

As it turns out, the analogy between increased incidence of seller financing with its lower down-payment percentage, and liberalized mortgage lending terms, breaks down because of the difference in tax treatment. The analogy that might be suggested, however, is that just as the seller is interested in more than simply the price per acre of land, the buyer, in contemplating his purchase, is also aware of more than the price per acre. He is aware of the total acquisition costs of the land which are influenced by the financing terms and his current financial structure.

The Market for Mortgage Debt

The second area of relevant literature deals with the determinants of loan demand for land purchase. A well-known study by Hesser and

¹Discounting at a lower rate would result in a higher present value and thus require a lower selling price to maintain equality of present value.
Schuh [1962] represents an early attempt at an econometric model of the demand for farm mortgage credit. The authors' intent was not to explain land prices or values, but to explain the gross flow of mortgage credit into agriculture. Mortgage credit is needed to finance the acquisition of new capital, to finance the transfer of existing capital and to refinance an existing mortgage or contract. Among the important variables included by the authors in their model are the "price" of credit, proxied, in their case, by the interest rate on farm mortgages; and the rate of savings in agriculture, which is used as a measure of internally generated funds available for capital acquisition.\(^1\) Other variables are included to capture the derived nature of mortgage credit demand, derived, that is, from the demand for farm land. These variables consisted of the farm labor wage rate, a measure of technological progress, and a measure of expected prices.

Three separate equations were estimated. Variables common to each were the interest rate, the level of internal funds, the farm wage rate, and the technology variable. Each equation also included variables unique to itself, such as the number of farm transfers, the quantity of farm mortgage credit lagged one year, and the stock of farm mortgage debt at the beginning of the year.

The authors encountered some problems in the statistical estimation of the equation. The period of time over which the equation was estimated, 1921 to 1959, considered necessary for full identification of

\(^1\) Term to maturity and size of down payment are other elements of the "price" of a loan.
the model, was of such a length as to make the authors suspect structural change in the credit market. The identification problem itself was not solved since empirical evidence led the authors to believe that both the supply and demand curves for farm mortgage credit had shifted over the period of the analysis.

Despite these and other problems, the results of the analysis were revealing in that they showed the demand for farm mortgage credit to be influenced by the interest rate, the volume of internal funds available, the level of technology and the farm wage rate. Short-run elasticities for the first three variables were greater than one in absolute value and negative in sign indicating that farm mortgage credit demand would increase with a decrease in the "price" of credit, a decrease in internal funds availability and a decrease in the level of technology. The latter may be more appropriately stated as follows: an increase in technology, allowing more substitution in production, leads to a decrease in the demand for mortgage credit. The short-run elasticity of demand for mortgage credit with respect to the farm wage rate, also greater than one in absolute value, was positive in sign. The conclusion regarding the farm wage rate is that as labor costs increase, land tends to be substituted and thus, the demand for credit increases.

Lins [1972] presented a model for estimating net changes in farm real estate debt by lending institution. He confined his definition of loan demand to those loans secured for the purchase or improvement of farm real estate assets. Thus, he did not consider those loans secured by real estate but used for non-real estate or nonfarm uses. The
lending institutions considered were the Farmer's Home Administration, the Federal Land Bank, private insurance companies, commercial bankers, and other individuals. A separate demand and supply equation was specified for each lending institution, the aggregate demand for farm mortgage loans being the sum of the loan demands for each individual institution. The variables chosen for the demand equation included the cost of borrowing, net farm plus nonfarm income, capital appreciation on farm real estate and the ratio of money balances to gross production expenses. The variables included in the supply function differed by lending institution, but included, in each case, some measure of interest rate received on loans, the spread between farm mortgage loans and alternative investment opportunities and the total potential funds available from that lending source. The demand for Federal Land Bank loans was estimated by ordinary least squares, while the demand for loans from commercial banks, life insurance companies and individuals were estimated by two-stage least squares. ¹ The demand for FHA loans was not estimated, but was assumed to represent congressional appropriations for FHA direct lending.

The results, although troubled by frequent statistical insignificance of variables and occasional contrariness of signs, suggested that elasticities of demand for credit varied by lending institution. Lins had hypothesized a highly inelastic demand at the aggregate level. The

¹ A supply estimate was not made for the Federal Land Bank because it is a cooperative and the quantity supplied is primarily determined by the quantity demanded [Lins, 1972, p. 4].
own price elasticity of demand for Federal Land Banks, for example, was -0.10, while that for life insurance companies was -8.37 [Lins, 1972, p. 6]. Another interesting result was that net changes in real estate debt were more sensitive to changes in income than to capital appreciation. The supply of real estate debt turned out to be sensitive to the yield differential on alternative investment opportunities.

Theoretical Antecedents

The most comprehensive treatment of the interrelationship among production, investment, and financing decisions is found in Vickers [1968]. Vickers presents three summary propositions that he feels are warranted by his analysis. First, the theories of production and capital, which developed along disparate lines, need to be shown as mutually relevant and logical only insofar as they take each other into consideration. Second, firms can attain an optimal structure of assets through investment choice and an optimal structure of liabilities through choice of financing method. Achievement of these optima is consequential to both product output and factor input selection. Finally, capital use and availability have an impact on the optimal mix of capital with other factors in a production process, an impact that extends to the conditions under which firms grow.

The general model advanced by Vickers is of the following form:

\[
\max \phi = \frac{1}{\rho(D)} [p(Q)f(X,Y) - \gamma_1 X - \gamma_2 Y - r(D)D]
\]  

(2.1)
subject to:

\[ \bar{K} + D = g(Q) + \alpha X + \beta Y \]  

(2.2)

where

\( \rho = \) equity owner's capitalization rate shown to be functionally dependent on \( D \), the total amount of debt capital employed by the firm;

\( p = \) unit selling price of the firm's output shown here to be dependent on the quantity of output sold;

\( X, Y = \) input factors of production, described more precisely as the number of units of the respective factor capacities employed;

\( Y_1, Y_2 = \) unit factor costs of inputs \( X \) and \( Y \), respectively;

\( r = \) average rate of interest on total debt employed by the firm;

\( \bar{K} = \) amount of equity capital employed by the firm, given and fixed;

\( g(Q) = \) net working capital requirement function which describes the firm's net investment in working capital to be a function of the level of production; and

\( \alpha, \beta = \) money capital requirement coefficients of factors \( X \) and \( Y \), respectively, indicating, for example, that for each unit of factor \( Y \) capacity employed by the firm, an investment in fixed assets of \( \beta \) dollars is required.

The maximand \( \phi \) represents the before-tax profits of the firm, discounted by the owner's capitalization rate. The capitalization rate, \( \rho \), has the form
\[ p = a + \omega^2 \]  

(2.3)

which makes it a linear function of \( \sigma^2 \), the variance of expected profits. The parameter "a" reflects the "risk free" rate of return, while "\( \omega \)" reflects owner attitude toward risk. The capitalization rate is said to be functionally dependent on total debt capital employed by the firm. This dependency results from the impact of financial leverage on the variance of expected profits. With a given equity base, an increase in debt use, with its concomitant rise in fixed interest charges, increases the variance in expected profits. For example, with \( N \) referring to net income, and \( O \) and \( M \) to net operating income and total interest on debt capital, respectively,

\[ N = O - M \]  

(2.4)

or, in terms of expected values,

\[ E(N) = E(O) - M \]  

(2.5)

Assuming that

\[ \text{Var}(N) = \text{Var}(O) \]  

(2.6)

then

\[ \sigma_N = \sigma_O \]  

(2.7)

and the coefficient of variation of net income, defined as \( \sigma_N/E(N) \) can also be written
where $r_D = M$, the total interest on debt capital. The coefficient of variation, a measure of risk, rises with increases in $r_D$. Recalling the form of $\rho$, the capitalization rate,

$$\rho = a + w_0^2$$

then,

$$d\rho = 2w_0 d\sigma$$ \hfill (2.10)

Substituting the coefficient of variation, $V_N = \frac{\sigma}{E(N)}$, for the variance in expected profits, $\sigma^2$, then,

$$dV_N = \frac{1}{N} d\sigma$$ \hfill (2.11)

and

$$d\sigma = NdV_N$$ \hfill (2.12)

Therefore,

$$d\rho = 2w_0 NdV_N$$ \hfill (2.13)

or

$$d\rho = 2w_0 N^2 V_N dV_N$$ \hfill (2.14)

since $\sigma = V_N N$. Taking the indefinite integral of the last equation with respect to $\rho$,

$$\rho = w_0 N^2 V_N^2 + C$$ \hfill (2.15)
Thus, the capitalization rate will vary directly with the coefficient of variation.

The constraint imposed on the objective function represents a limitation on the availability of money capital. Money capital arises from two sources: owner's equity and debt. Money capital requirements likewise arise from two sources, one being the need for working capital to bridge the time gap between expenditures and receipts that occur during production. Working capital, usually identified as the excess of current assets over current liabilities, is considered a function of the level of output of the firm. The second use of money capital is in the investment in fixed assets. In a world where factor services are not completely variable, some investment in fixed assets, which provide a flow of factor services over their lifetime, is required. These investments, necessary to the production of output by the firm, call for money capital. The money capital requirement measures the investment necessary to secure the fixed asset. Vickers' model of firm behavior is constrained such that money capital requirements must not exceed the firm's money capital supply from debt and equity sources. Since the total money capital requirement is dependent on the level of output and the level and combination of inputs, it cannot be known for certain until output decisions are made. But, in the face of money capital scarcity, the optimal level of output and the optimal level and combination of inputs must be influenced by both sides of the constraint equation. Thus, in Vickers' model, the production and investment decisions are simultaneous.
Utilizing the Lagrangian method in taking derivatives with respect to the decision variables in the model, X, Y and D and the Lagrangian multiplier, \( \mu \), yields not only the firm's demand for inputs X and Y, but also, with K fixed, its optimal capital budget and its optimal debt-equity ratio.

It is possible, as Vickers points out in a subsequent article [Vickers, 1970], to determine the optimal level of equity as well, thus achieving what the author terms the optimum optimorum. For a given level of equity, the marginal productivity of money capital, given by \( \mu \), the Lagrangian constraint, measures the value of additional debt. Once the optimal amount of debt for a given level of equity is obtained, the marginal productivity of money capital becomes a measure of the value of additional equity. At the optimum optimorum, \( \mu \) is equal to one.

A similar model was developed by Turnovsky [1970], but with an emphasis on the case in which both debt and equity levels are chosen in conjunction with factor-outputs [Turnovsky, 1970, p. 1061]. The model he employs optimizes the firm's net discounted present value subject to the capital requirement constraint. The optimization yields the desired level and mix of factor inputs, the desired combination of debt and equity financing and the demand level of the capital budget, i.e. the sum of total debt and equity employed by the firm.

Turnovsky also indicates how the firm can reach its long-run equilibrium through a sequential process rather than the simultaneous process described by Vickers. The firm first selects its optimal financial structure by choosing the leverage ratio that minimizes its
cost of capital. The cost of capital enters the input demand equations and, given output price and factor costs, determines the optimal production level. The production decision, in turn, determines the optimal capital budget or in the case of the firm as a whole, the total level of assets [Turnovsky, 1970, p. 1070].

One final issue raised by Turnovsky is an examination of how, under the assumption of a given initial level of equity, a firm would respond, in terms of its debt use, to changes in that level of equity. In other words, the analysis suggests under what conditions a firm will regard debt and equity as complements and under what conditions it will regard them as substitutes. His conclusion is that the initial level of equity itself determines the outcome. If the initial level is small, the firm will regard equity and debt as complements. If the initial level is large, it will regard the two financing sources as substitutes. If \( K \) happens to be at its long-run equilibrium and the firm can borrow at a rate of interest independent of the leverage ratio, debt and equity can be regarded as substitutes. If the rate of interest rises with the leverage ratio, it is possible for debt and equity to be viewed as complements [Turnovsky, 1970, p. 1078].

Related work in the area of agricultural finance was reported by Baker [1968a]. He asserts the inadequacy of the condition

\[
\frac{-dx_2}{dx_1} = \frac{\rho_1}{\rho_2}
\]

(2.16)

to determine the optimal combination of inputs \( x_1 \) and \( x_2 \) in the production of output. He proposes, instead, the following condition,
\[-\frac{dX_2}{dX_1} = \frac{F_1 + F_1}{F_2 + F_2}\]  \hspace{1cm} (2.17)

where $F_1$ and $F_2$ represent the marginal cost of financing each unit of $X_1$ and $X_2$, respectively. According to Baker, the necessity of having to finance the purchase of inputs is important in that it lessens a farmer's liquidity through the absorption of his credit, i.e. his unused borrowing capacity. Liquidity is an important resource to the farmer. While not appearing as an asset on his balance sheet, it is nevertheless, important as it provides a response to uncertainty. To the extent that the marginal financing costs, the $F_i$'s in Baker's formulation, reflect more than just the interest rates charged on loans for different inputs, Baker's equilibrium condition is consistent with the work of Vickers and Turnovsky. If, for example, the $F_i$'s reflect loan limits on the purchase of different inputs, a suggestion the author himself makes, then the condition establishes a link between financial structure and input mix. If it is assumed that the ratio of input financing costs is equal to the ratio of input prices, then the input mix would be the same whether or not the purchase had to be financed. But, if the ratios are different, a more likely situation in Baker's opinion, then the necessity of having to finance input purchases will have, at least potentially, an impact on the input mix.

In a subsequent paper, Baker [1968b] employs his earlier analysis in an attempt to explain why farmers typically want to own land instead of lease it and why they would finance land purchases with a mortgage rather than a land contract. The cost-minimizing choices would seem to
be to lease rather than buy and to finance with a land contract rather than a mortgage. Building on the ideas of his earlier paper, Baker suggests that because farmers value liquidity and that because credit is a source of liquidity, the land acquisition method that farmers choose may be that method that supports the most credit. Equity in land financed with a conventional mortgage typically supports more credit than equity in land financed with a land contract. Land leases, of course, offer no additional credit base to the farmer.

Baker never mentions the existence of a money capital requirement for inputs, but he does view the production problem as one of constrained optimization. Farmers maintain a capital structure that satisfies their liquidity needs as well as their production goals. Equity provides borrowing capacity which represents a source of liquidity to the farmer. Unused borrowing capacity, or credit, provides a "line of defense" against uncertainty. Therefore, in selecting inputs, farmers may be responsive to the terms under which those inputs can be financed. Inputs with higher lending limits (lower down payments) may be favored over those with lower lending limits, ceteris paribus, since the greater absorption of credit by the latter imposes a cost on the farmer in terms of decreased liquidity. This decreased liquidity might be reflected in a higher capitalization rate in a valuation model such as that specified by Vickers.

Summary

As mentioned previously, this review is meant to be representative, not exhaustive. There exists an extensive literature on the factors that
determine farm land values. While financial variables are often assigned a significant role, few studies have centered on these variables or examined the theoretical basis for the significance of the down-payment percentage in the formation of farm land prices. Fewer still have offered empirical evidence. The highly aggregated data used in empirical studies, such as that by Reynolds and Timmons, fail to capture the interrelationships among land price, down-payment percentage, and firm financial structure.

The literature on firm behavior under capital scarcity is likewise vast. However, few have investigated the impact of money capital scarcity, and none have directly addressed the issue of the impact of capital structure on the price of fixed assets.
CHAPTER III. A MODEL OF FARM FIRM BEHAVIOR UNDER CONDITIONS OF CAPITAL SCARCITY

Because existing theoretical models are inadequate to investigate the issue of capital structure and farm land prices, it is the purpose of this chapter to develop a model that establishes that conceptual link. The model is based on the work of Vickers, but makes critical adaptations to be applicable to the issues of this study. First, the theoretical model describing both the objective function and the constraint is presented. Second, the model is optimized and conditions necessary for achieving a constrained maximum solution are derived. Finally, a comparative static analysis which examines the impact on the endogenous variables of changes in the exogenous variables is presented.

Specification of the Objective Function

In a study of six large California farms, Lin et al. [1974] concluded that farmer behavior is more accurately explained by utility maximization (specifically, Bernoullian utility) than by profit maximization. Using the chi-square goodness-of-fit criterion as their measure, the authors showed that the Bernoullian utility formulation provided the most accurate prediction of actual cropping patterns among the six farms included in the study.¹ Their hypothesis was that farmer attitude toward risk is the factor which contributes most to the discrepancy between actual optimizing behavior and that predicted by profit maximizing

¹The chi-square goodness-of-fit test compares the postulated probability distribution with that suggested by the data to determine whether they are, in fact, the same.
models. Risk is not properly accounted for in conventional profit maximizing models, but can easily be incorporated in a utility maximizing function. Profit maximization can be regarded as a special case of Bernoullian utility maximization, the case in which the decision maker has a constant marginal utility of income.

In addition to the Bernoullian utility function, Lin et al. [1974] also tested a lexicographic utility function which included four goals: one representing family living standards; another, the level of firm growth; a third, net income; and the fourth, the degree of risk aversion. In the context of lexicographic utility, the decision maker is assumed to maximize (or minimize) the least important goal subject to satisfactory levels of the other goals [Lin et al., 1974, p. 503]. The lexicographic utility formulation, as it turned out, performed only slightly better than the profit maximization formulation.

The suggestion of the Lin et al. [1974] study and of earlier studies [Officer and Halter, 1968; Dillon and Anderson, 1971; and Massell and Johnson, 1968] is that farm decision makers act as utility maximizers rather than profit maximizers. Utility can be defined as a function of "returns" and "risks"; more specifically, a function of expected returns such that

\[ U = F(R, \sigma^2) \]  \hspace{1cm} (3.1)

\[ F_1 > 0, \quad F_2 < 0 \]  \hspace{1cm} (3.2)

where \( U \) = utility, \( R \) = expected returns, \( \sigma^2 \) = risk of returns and \( F_1 \) and \( F_2 \) represent the changes in the utility function with respect to \( R \) and \( \sigma^2 \), respectively. This view of farmer behavior accords well with the
general formulation of Vickers. The model specified by Vickers defines what is termed the "economic value of ownership" [Vickers, 1968, p. 8]. Recalling the form of the objective function,

\[ \max \phi = \frac{1}{\rho(D)} [p(Q)f(X,Y) - r(D)D - \gamma_1 X - \gamma_2 Y - r(D)D] \]  

(3.3)

where all symbols are as defined previously, the variable being maximized is the return to the owners of the firm, in Vickers' case, the firm's stockholders. Consequently, gross revenue must be reduced not only by input costs, but by interest expense as well. This specification allows the full consideration of the impact of the method of financing on the return to ownership. Because utility is a positive function of returns, the model specification forges a link between the objective function and the generalized utility function.

The equity owner's capitalization rate, \( \rho \), as discussed in Chapter II above, is a function of, among other factors, the variability of the firm's returns. It is defined as

\[ \rho = a + \sigma^2 \]  

(3.4)

where \( \sigma^2 \) represents the variance in returns. Assuming that utility is a negative function of the variance in returns, the presence of the capitalization rate completes the link between Vickers' objective function and a generalized utility function. Recalling from Chapter II that the variance in returns to the residual owner is magnified by an increase in financial leverage, then the capitalization rate is also shown to be an increasing function of the degree of financial leverage.
The capitalization rate represents the rate of return on equity capital that the stockholder deems necessary to maintain his or her ownership in the firm. It is defined so as to reflect the amount of debt in the firm's financial structure. As the proportion of debt-to-equity increases, *ceteris paribus*, the equity owner, as residual claimant, evaluates the return from investment in the firm at a higher rate to account for the increased variance in that return.

The equity owner's capitalization rate can be regarded as a component of the firm's cost of capital. As usually conceived, the cost of capital is a weighted average of the firm's cost of debt and equity capital, respectively. The firm's cost of equity is equivalent to the equity owner's capitalization rate. As the unlevered firm adds more debt to its capital structure, *ceteris paribus*, its cost of capital will likely decrease, the cost of debt capital being less than the cost of equity capital. This result occurs despite the rise in the cost of equity occasioned by the increase in debt use. After a certain point, however, the cost of capital will rise as the increase in debt use pressures both debt and equity costs upward.

The transition from corporation to sole proprietorship, while calling for some modifications, is not difficult. The sole proprietor can be considered to have a required rate of return on equity to be used in evaluating the worth of capital expenditures to the firm. He would likewise use this rate in discounting the total stream of returns to equity in the business. The basis for this rate is the same as that for a stockholder in a corporation. The rate should reflect the owner's or
 investor's opportunity return; that is, the return required to cover the
cost of not investing the value of the equity in an alternative
occupation of comparable risk. This rate could also be adjusted to
reflect the impact of inflation on future cash flows as an alternative to
projecting the real value of future cash flows.

If a stockholder in a company finds that better yields are available
on alternative investments of similar risk, then he would sell his shares
in that company and purchase shares in another. Similarly, the sole
proprietor who finds superior investment opportunities in the same risk
class as his business may liquidate his assets and invest his equity in
the alternative occupation. Two problems arise that make the analogy
between stockholder and sole proprietor less than perfect. First, the
stockholder often faces a liquid securities market in which he can buy and
sell with relatively small transactions costs. A proprietor, on the other
hand, whose equity consists of real as well as financial assets may face
a much less liquid market. Thus, high transactions costs may lower the
proprietor's opportunity rate of return as compared to the stockholder.
Second, the proprietor may place a value on the return to his equity in
his business that exceeds the value of the cash returns. The business
may be thought of as providing continued employment and the equity thus
valued more than a stockholder's equivalent ownership equity in a
corporation. Despite these differences in the position of stockholders
versus proprietors, the equity owner's capitalization rate, as envisioned
by Vickers, would appear to be suitable for use in the present study.
Thus, the objective function to be employed in the present study is basically that used by Vickers. Some changes have been made to apply the model to the issues at hand and to aid in the analysis. The objective function is:

$$\max \phi = \frac{1}{\rho} [p Q - \gamma_1 X_1 - k \gamma_2 X_2 - r D]$$  \hspace{1cm} (3.5)

where

- $\phi$ = the capitalized value of the pre-tax return to the residual (or equity owner);
- $\rho$ = the residual owner's capitalization rate. Given a level of equity and a constant level of business risk, the capitalization rate varies with the amount of debt employed. It is defined as $\rho = a + t D$;
- $p$ = the expected selling price of the firm's output;
- $Q$ = the quantity of output produced, $Q = f(X_1, k X_2)$ where $X_1$ and $X_2$ refer to flow and stock inputs, respectively;
- $k$ = the proportion of the total stock of input $X_2$ used in production;
- $\gamma_1, \gamma_2 =$ acquisition costs of inputs $X_1$ and $X_2$, respectively; and
- $r D =$ total interest expense, the product of average interest rate on debt, $r$, times total indebtedness, $D$.

This model is basically an asset valuation model in which the maximand represents the present value of the return to the residual owner's share of the firm's assets. It could alternatively be expressed as
\[ \phi = \frac{E(R)}{\rho} \]  

(3.6)

where \( E(R) \) stands for expected returns to the equity owner and \( \rho \), as before, refers to the equity owner's capitalization rate.

A more realistic asset valuation model might allow for the possibility of changes in the level of expected returns through consideration of a rate of growth in such returns. In the context of the present analysis, which has as its goal an explanation for some of the variation in farm real estate prices, this growth aspect may be especially relevant. According to Melichar [1979], farm real estate can be compared to a "growth stock" where part of the present value of the asset lies in expected growth in dividends over the holding period.

Following Van Horne [1974],

\[ \phi = \frac{R(1+g)}{(1+\rho)} + \frac{R(1+g)^2}{(1+\rho)^2} + \ldots + \frac{R(1+g)^n}{(1+\rho)^n} \]  

(3.7)

where \( g \) represents the expected growth rate in returns and \( R \) represents dividends, or, in the farm land analogy, cash withdrawals. Assuming that \( \rho > g \), this formula reduces to

\[ \phi = \frac{R (1+g)}{(\rho-g)} \]  

(3.8)

as \( n \to \infty \).

This formulation suggests that the present value of the residual ownership in the firm, \( \phi \), may change with the level of current cash withdrawals, \( R \), the rate of growth in those cash withdrawals, \( g \), or the discount rate, \( \rho \). Identifying \( g \) as the real rate of growth means that it must be adjusted for the effects of general price inflation.
Recalling the form of the objective function, the level of expected returns in any period can be seen to be a function of the expected selling price of output times total output produced minus total variable costs, machinery ownership costs, land charges, opportunity returns to management and operator labor and return to borrowed capital (interest expense). Each of these elements could have an associated expected real rate of growth which taken together would determine \( g \), the real rate of growth in expected returns.

**Specification of the Money Capital Constraint**

Reference has been made previously to the impact of capital scarcity on firm behavior. The requirement that a firm finance the acquisition of inputs adds a new feature to the neoclassical model of firm behavior.

Under conditions of capital saturation and with the freedom to vary both output levels and total cost, the firm might maximize the following function,

\[
\Pi = pQ - C
\]  

(3.9)

where \( \Pi \) refers to profits, \( pQ \) refers to total revenue from the sale of output \( Q \) at price \( p \), and \( C \) refers to total costs, both fixed and variable. If inputs \( X_1 \) and \( X_2 \), available under conditions of pure competition, are used in the production process, then \( Q \) can be written in the form of a production function \( Q = f(X_1, X_2) \) and \( C \), total costs, in the form \( C = r_1X_1 + r_2X_2 + b \) where \( r_1 \) and \( r_2 \) represent unit costs of inputs \( X_1 \) and \( X_2 \), respectively, and \( b \) equals total fixed costs. Thus,
Differentiating with respect to $X_1$ and $X_2$,

\[
\frac{d\Pi}{dX_1} = pf_1 - r_1 = 0
\]  

(3.11)

\[
\frac{d\Pi}{dX_2} = pf_2 - r_2 = 0
\]  

(3.12)

and rearranging terms, the profit maximizing conditions are

\[
pf_1 = r_1 \text{ and } pf_2 = r_2 .
\]  

(3.13)

The value of the marginal product of each input must equal that input's marginal unit cost. Because the profit maximizing combination of $X_1$ and $X_2$ lies on the firm's expansion path, the condition

\[
\frac{pf_1}{pf_2} = \frac{r_1}{r_2}
\]  

(3.14)

also holds at the optimum. Equation (3.14) states that the ratio of the marginal physical products of inputs $X_1$ and $X_2$ equals the ratio of the two inputs' unit costs. Geometrically, this equilibrium is represented by the tangency of the isoquant with the inputs' price line. If unit costs $r_1$ and $r_2$ are assumed to include the costs of financing the acquisition of inputs $X_1$ and $X_2$, then the previous condition will also hold in the case of capital scarcity, but only if the ratio of financing costs equals the ratio of input costs.
If the firm is assumed to be maximizing output subject to a budget constraint so that the objective function is

\[ V = f(X_1, X_2) + \mu(c^0 - r_1X_1 - r_2X_2 - b) \quad (3.15) \]

where \( \mu \) is a Lagrangian constraint variable and \( c^0 \) the fixed budget, then the condition

\[ \frac{f_1}{f_2} = \frac{\mu x_1}{\mu x_2} \quad (3.16) \]

once again holds at the optimum. While the budget constraint could be construed as a money capital constraint, the manner in which it is typically employed fails both to discriminate between the sources of money capital and to detect the differences in the money capital requirements of the different inputs. A more useful model of firm behavior under capital scarcity would make explicit the distinction between per-period unit input costs and money capital requirements per unit of input employed.

Per-period unit input costs accrue per unit of input employed in the time period under consideration. Hired labor costs, for example, can be expressed in dollars per man hour, fertilizer or feed costs in dollars per pound or gallon used during the accounting period. For rented inputs or owned capital inputs employed over a number of accounting periods, the per-period unit input cost can be expressed as a rental fee or a periodic depreciation charge. Per-period input costs, in other words, are the costs that would appear as expenses for a particular time period on a firm's income statement.
Per-unit money capital requirements, on the other hand, refer to the cash investments required to employ particular inputs in production. Specific variable inputs such as hired labor and rented capital inputs may have no money capital requirements, while fixed inputs would almost certainly require a permanent investment of money capital. Money capital requirements can be identified as the acquisition costs of assets that appear on a firm's balance sheet. Thus, the total acquisition costs of long-term assets such as land and buildings and intermediate-term assets such as machinery, equipment and breeding livestock could be considered to constitute those assets' money capital requirements. These assets are acquired in one period to be used over the course of succeeding periods.

Many short-term assets would also have money capital requirements due to the mismatch in the timing of revenue inflows and cost outflows during a given accounting period. Cash, receivables, inventories of inputs, goods-in-process, and finished goods are all held to satisfy liquidity requirements, production needs, or marketing strategies. These investments would, therefore, help determine the money capital requirements of short-term assets. Much of the value of these assets is financed by short-term liabilities such as accounts payable or short-term notes due. To the extent that these short-term liabilities finance a given level of short-term assets, no permanent investment of money capital is required to maintain that level of assets. The excess of short-term assets over short-term liabilities, that is, working capital, represents the money capital requirement of short-term assets. It
represents the portion of those assets that is financed by long-term debt or equity.

The term, money capital, does not refer to any specific form of asset, but instead refers to purchasing power. It, therefore, represents a constraint to the firm and not a productive asset such as land or labor. As money capital is transformed into physical assets through the purchase of capital assets or the maintenance of a certain level of working capital, it becomes productive.

Given this distinction between per unit input costs and money capital requirements, it becomes apparent that a budget constraint and a money capital constraint may be completely different. A firm could find its capital constraint nonbinding because few fixed inputs are purchased or working capital requirements are low while being constrained by total operating expenditures. On the other hand, production of a given level of output could be feasible in the context of the operating budget, yet infeasible given the magnitude of fixed asset costs or working capital requirements.

Recalling that the two sources of money capital are debt and equity, the latter arising from either the issuance of stock or the retention of earnings, then the constraint on money capital can be expressed as follows:

\[ K + D = g(Q) + c_1 X_1 + c_2 X_2 \]  (3.17)

where \( K \) and \( D \) represent equity and debt, respectively, and \( g(Q) \) represents the working capital requirement which is assumed to depend on
the level of output. The parameters $c_1$ and $c_2$ represent the money capital requirements that can be attributed to each input, $X_1$ and $X_2$, respectively.

Optimization of the Model

Adding the money capital availability constraint in Equation (3.17) to the profit equation defined in Equation (3.10) forms the Lagrangian function,

$$L = f(X_1, X_2) - r_1X_1 - r_2X_2 - b + \lambda (K + D - g(Q)) - c_1X_1 - c_2X_2.$$  

(3.18)

Differentiating with respect to inputs $X_1$ and $X_2$ and setting the results equal to zero yields the first order conditions for a constrained maximum,

$$\frac{\partial L}{\partial X_1} = pf_1 - r_1 - \lambda (g'f_1 + c_1) = 0 \quad \text{and} \quad (3.19)$$

$$\frac{\partial L}{\partial X_2} = pf_2 - r_2 - \lambda (g'f_2 + c_2) = 0 . \quad (3.20)$$

Rearranging Equations (3.19) and (3.20) yields

$$pf_1 = r_1 + \lambda (g'f_1 + c_1) \quad \text{and} \quad (3.21)$$

$$pf_2 = r_2 + \lambda (g'f_2 + c_2) \quad . \quad (3.22)$$

A further rearrangement yields

$$f_1 (p - \lambda g') = r_1 + \lambda c_1 \quad \text{and} \quad (3.23)$$
\[ f_2 (p - \lambda g') = r_2 + \lambda c_2 . \quad (3.24) \]

The difference between these first order conditions and those derived from the usual, unconstrained, profit maximizing function arises from the presence of the money capital constraint. On the left-hand side of Equations (3.23) and (3.24), the value of the marginal product of inputs \( X_1 \) and \( X_2 \), respectively, must be reduced by the imputed marginal cost of the additional working capital necessitated by the employment of more of the inputs. On the right-hand side, to the marginal factor cost of inputs \( X_1 \) and \( X_2 \), respectively, are added the imputed costs of acquiring the inputs. The imputed values on both sides of the equation vary with the degree of scarcity of money capital. If money capital were not scarce, the conditions would be identical to those of the usual, unconstrained case.

The impact of the money capital requirement on the level of employment of particular inputs can be seen by, first, totally differentiating Equations (3.19) and (3.20). The total differentiation yields

\[
p f_{11} dX_1 + p f_{12} dX_2 + f_1 dp = \lambda g f_2 dX_2 + \lambda f_1 dg' + g f_1 d\lambda
\]

\[ + \lambda d\lambda + c_1 d\lambda \quad \text{and} \quad (3.25)\]
Rearranging the total differentials in matrix form yields,

\[
\begin{bmatrix}
  f_{11}(p - \lambda g') & f_{12}(p - \lambda g') \\
  f_{21}(p - \lambda g') & f_{22}(p - \lambda g')
\end{bmatrix}
\begin{bmatrix}
  dx_1 \\
  dx_2
\end{bmatrix}
= \begin{bmatrix}
  -f_1 dp + dr_1 + \lambda(f_1 dg' + dc_1) + (g'f_1 + c_1) d\lambda \\
  -f_2 dp + dr_2 + \lambda(f_2 dg' + dc_2) + (g'f_2 + c_2) d\lambda
\end{bmatrix}.
\]

Assuming that the Jacobian,

\[
|J| = (f_{11} f_{22} - f_{12}^2)(p - \lambda g')
\]

is nonsingular and positive, then, by Cramer's rule,

\[
\frac{dx_1}{dx} = \frac{|J_1|}{|J|};
\]

where

\[
|J_1| = f_{22}(p - \lambda g')( -f_1 dp + dr_1 + \lambda(f_1 dg' + dc_1) + (g'f_1 + c_1) d\lambda)
\]

\[
- f_{12}(p - \lambda g')( -f_2 dp + dr_2 + \lambda(f_2 dg' + dc_2) + (g'f_2 + c_2) d\lambda) .
\]
Differentiating with respect to $c_1$ while holding all other variables and parameters constant gives

$$\frac{dX_1}{dc_1} = \frac{f_{22}(p - \lambda g')\lambda}{|J|}. \quad (3.31)$$

As long as the Lagrangian constraint, $\lambda$, is binding ($\lambda > 0$) and as long as input $X_2$ exhibits diminishing marginal productivity ($f_{22} < 0$), then

$$\frac{dX_1}{dc_1} < 0, \quad (3.32)$$

meaning that an increase in the money capital requirement of a particular input reduces the level of employment of that input.\(^1\)

Therefore, a shift in relative input use or a change in output can occur even in the absence of a change in unit input prices. A change in the money capital requirement of an input is sufficient for this to occur. The equilibrium condition in the case of capital scarcity is

$$\frac{f_1}{f_2} = \frac{r_1}{r_2} + \frac{\lambda c_1}{\lambda c_2}. \quad (3.33)$$

The introduction of the money capital requirements, the $c_i$'s, will result in a different conclusion than the case of no money capital requirements unless either $\lambda = 0$, meaning that capital is not scarce, or the ratio of the money capital requirements equals the ratio of the per-period unit

\(^1\)This result also requires that $p - \lambda g' > 0$, a condition which must exist if Equations (3.23) and (3.24) are to yield reasonable results.
It is also of interest to know the impact of easing the money capital constraint on both the value of the objective function and the optimal levels of input employment. Recalling the form of the Lagrangian function,

\[ L = pf(x_1, x_2) - r_1x_1 - r_2x_2 - b + \lambda(K + D - g(Q) - c_1x_1 - c_2x_2), \]

(3.34)

the variable \( \lambda \) measures the impact of the money capital constraint on the value of the objective function when that function is at its optimum [Intriligator, 1971, p. 60]. Thus,

\[ \lambda^* = \frac{\partial L^*}{\partial (K + D - g(Q) - c_1x_1 - c_2x_2)} \]

(3.35)

where asterisks indicate that the variables are at their respective optima. An easing of the constraint can arise from either an addition of debt or equity capital or a diminution of the money capital requirements.

Assuming no change in the money capital requirements, expressing debt, \( D \), as a fraction of total equity, \( K \), so that

\[ D = \delta K \]

(3.36)

and defining total money capital available as

\[ K + \delta K = K(1 + \delta) \]

(3.37)
then

\[ \lambda^* = \frac{\partial \lambda^*}{\partial \left[ K(1 + \delta) \right]} \]  
(3.38)

Thus, an increase in \( \delta \), which represents the ratio of debt to equity, can serve to ease the money capital constraint. The expression in Equation (3.38) can be interpreted as the change in value to the objective function of increasing the leverage ratio of the firm.

With a fixed level of equity, selection of an accompanying level of debt is tantamount to selection of a leverage ratio. At the limit, the money capital constraint can become a limit on debt use. It remains to indicate the role of the down-payment (or alternatively, loan-to-value) ratio in the context of the money capital constraint. Assuming that the money capital constraint is binding, an increase (decrease) in the allowable loan-to-value ratio would serve to ease (tighten) the constraint.

Application to Farm-Firm Analysis

The money capital constraint to be used in this study will be modified in several respects from the more general form presented in Equation (3.17). First, it will ignore the working capital requirement. Inclusion of a working capital term in the constraint would not materially alter the results of the analysis. It would merely tighten the money capital constraint for any given level of input use. Second, the constraint will identify input \( X_2 \) as the capital or stock input which requires a money capital investment and \( X_1 \) as the current or flow input which does not. Thus, only input \( X_2 \) will appear in the constraint. These
modifications are made in anticipation of the comparative statics analysis to be undertaken below. They will serve to simplify the analysis without affecting the results. The money capital constraint, as modified, is specified as follows:

\[ \bar{K} + D = \gamma_2 X_2 \]  \hspace{1cm} (3.39)

where

- \( \bar{K} \) = owner's equity fixed and given in this case;
- \( D \) = total debt of the firm; and

\( \gamma_2 X_2 \) = the total money capital requirement for the capital or stock input, \( X_2 \), that must be met before production of optimal quantity can begin. This value is the product of the unit price of the capital input times the number of units purchased. It represents, in other words, the acquisition costs or investment required to own a given amount of \( X_2 \).

There is a stock-flow problem implied by the formulation of the model. The objective function regards the flow of services from an input during the production period and the ensuing cost of that flow. The constraint, on the other hand, concerns the cost of obtaining a stock of inputs and the availability of money capital to finance the ownership of that stock. While the problem does not arise in the case of input \( X_1 \) which is representative of a broadly defined group of flow or current inputs, it is present in the case of input \( X_2 \) which is representative of a group of stock or capital inputs. This variable appears in both the objective function and the money capital constraint. The decision to be
made with regard to $X_2$ is how much of the input to employ in production, but that decision must take into account the costs of maintaining the stock of $X_2$ that provides the optimal flow of input services during the production period.

Consider

$$X_2 = \text{an input used over several production periods that embodies a flow of services (e.g., machine hours, shelter or storage years, acre years);}$$

$$\gamma_2 = \text{the acquisition cost or purchase price of one unit of input } X_2 \text{ (e.g., } ($/\text{machine hour})(\text{machine hours/unit}), ($/\text{shelter year})(\text{shelter year/unit}), ($/\text{acre year})(\text{acre years/acre})\text{);}$$

$$k = \text{the factor that converts the stock input into an annual flow. It can be regarded as the proportion of the services embodied in the stock input that are expended in a single production period.}$$

A tractor or combine, for example, embodies $n$ machine hours and its purchase price can be regarded as the product of $n$ machine hours and the price per machine hour. The factor $k$ can be considered to be an annual depreciation percentage for both the physical asset and its acquisition cost.

An additional problem, however, arises in the case of land. Land is usually considered to be of infinite durability. The stock of services embodied in an acre of land is not expended in the manner of machinery or building services. On the other hand, land is valued in finite dollar terms usually on the basis of the following valuation
formula:

\[ V = \frac{R}{i} \]  

(3.40)

where \( V \) represents the capitalized value of an acre of land, \( R \), the current returns to the land (often proxied by the rental rate) and \( i \), the decision maker's discount or capitalization rate. In the case of land, \( R \) would be a good approximation of the dollar value of services rendered during a production period. According to the valuation formula above, \( R = iV \). Assuming that \( i \) and \( V \) are equivalent to \( p \) and \( \gamma_2 \), respectively, then in the case of land, the factor \( k \) can be seen to equal \( p \), the equity owner's capitalization rate.

**Comparative Static Results**

Recalling the objective function in Equation (3.5) and the money capital constraint in Equation (3.39), the Lagrangian equation can be expressed as follows:

\[ L = \frac{1}{p \rho(D)} \left[ p Q - \gamma_1 X_1 - k \gamma_2 X_2 - r D \right] + \lambda \left[ R + D - \gamma_2 X_2 \right]. \]  

(3.41)

The decision variables in this model are \( X_1 \), \( X_2 \) and the Lagrangian constraint, \( \lambda \). The variable \( X_1 \) represents the quantity of the flow input to be used in the period while the variable \( X_2 \) represents the amount of the stock variable to be purchased, but not necessarily used, during the period under consideration. The total amount of debt employed by the decision maker is assumed to depend on policies of lenders. Thus, a leverage ratio is imposed on the decision maker. While this arrangement
bars the simultaneous determination of optimal input demand and optimal
debt level, it does allow input choice to be influenced by the
availability of money capital and to vary even in the absence of a
change in input costs.

Differentiating the Lagrangian equation with respect to the decision
variables and setting the results equal to zero yields the following
first order conditions.

\[
\frac{\partial L}{\partial x_1} = \frac{1}{\rho} [pf_{1} - \gamma_{1}] = 0, \quad (3.42)
\]

\[
\frac{\partial L}{\partial x_2} = \frac{1}{\rho} [pf_{2} - k\gamma_{2}] - \lambda\gamma_{2} = 0, \quad \text{and} \quad (3.43)
\]

\[
\frac{\partial L}{\partial \lambda} = K + D - \gamma_{2}X_{2} = 0. \quad (3.44)
\]

These equations represent the first order conditions for a
constrained maximum. They can be solved for the optimal level of input
use given exogenously determined debt and equity levels.

Equation (3.42) above can be rewritten as

\[
\frac{1}{\rho} pf_{1} = \frac{1}{\rho} \gamma_{1} \quad (3.45)
\]

The capitalized (or present) value of the marginal value product of
input \(X_{1}\) must, at the optimal employment level, equal the capitalized
value of the marginal factor cost of \(X_{1}\). This result does not differ
from the standard neoclassical result except insofar as it deals with
capitalized values. But even then, changes in the capitalization rate
would have no impact because both sides of the equation are equally affected.

Equation (3.43) above can be restated as follows:

$$\frac{1}{p} p f_2 - \lambda \gamma_2 = \frac{1}{p} k \gamma_2 \quad (3.46)$$

If \( k = p \), then

$$\frac{1}{p} p f_2 - \lambda \gamma_2 = \gamma_2 \quad (3.47)$$

which means that, at equilibrium, the present value of the marginal value product of \( X_2 \) minus the imputed value of the money capital investment in \( X_2 \) equals the acquisition price of \( X_2 \). Two things to note are first, that the marginal value product of \( X_2 \), or the returns to the stock input, must be capitalized if they are to be compared to the acquisition price, and second, that the significance of the money capital investment depends directly on the severity of the money capital constraint. If money capital is not scarce, \( \lambda \) would equal zero.

The more binding the money capital constraint becomes, the larger the value of \( \lambda \) becomes and the larger must be the return to the factor to justify its acquisition at a given price. On the other hand, a easing of the constraint reduces the value of \( \lambda \) and lowers the opportunity cost of the investment of money capital in a particular asset. In terms of the first order condition for input \( X_2 \), an increase (decrease) in the value of \( \lambda \), all other values held constant, decreases (increases) the value of the left-hand side of the equation, calling for a like change on the right-hand side in order to maintain
equilibrium.

In examining the particular case of land purchase decisions, if the price of land rises, the money capital constraint may become binding. Assuming a fixed equity base, a situation of particular relevance to beginning farmers who own little or no land, the amount of debt in the financial structure may become the limiting factor in attaining optimal size. The amount of debt required for the acquisition of higher priced land may be infeasible for one of two reasons. The decision maker may be faced with an internal constraint on the financial leverage he is willing to maintain or, as in the present model, he may be constrained by the amount that lenders are willing to lend.

Recall the first order conditions for a maximum,

\[ \frac{\partial L}{\partial x_1} = \frac{1}{\rho} \left[ pf_1 - \gamma_1 \right] = 0, \] (3.48)

\[ \frac{\partial L}{\partial x_2} = \frac{1}{\rho} \left[ pf_2 - k\gamma_2 \right] - \lambda \gamma_2 = 0, \text{ and} \] (3.49)

\[ \frac{\partial L}{\partial \lambda} = \bar{K} + D - \gamma_2 x_2 = 0. \] (3.50)

To determine whether these equations are, in fact, the first order conditions for a constrained maximum, the second order condition must be checked. Totally differentiating Equations (3.48), (3.49), and (3.50), respectively, and rearranging by grouping terms,

\[ \frac{p}{\rho} f_{11} dx_1 + \frac{p}{\rho} f_{12} dx_2 = \frac{1}{\rho} d\gamma_1 - \frac{f_1}{\rho} dp + \frac{t}{\rho_2} (pf_1 - \gamma_1) dD, \] (3.51)
\[ \frac{p}{p} f_{21} dx_1 + \frac{p}{p} f_{22} dx_2 - \gamma_2 d\lambda = (\frac{k}{p} + \lambda) d\gamma_2 + \frac{\gamma_2}{p} dk - \frac{f_2}{p} dp \]
\[ + \frac{t_2}{p} (p f_2 - k\gamma_2) dD, \text{ and} \]
\[ - \gamma_2 dX_2 = X_2 d\gamma_2 - dK - dD. \] (3.52)

In matrix form,
\[
\begin{pmatrix}
\frac{p}{p} f_{11} & \frac{p}{p} f_{12} & 0 \\
\frac{p}{p} f_{21} & \frac{p}{p} f_{22} & -\gamma_2 \\
0 & -\gamma_2 & 0
\end{pmatrix}
\begin{bmatrix}
dx_1 \\
dx_2 \\
d\lambda
\end{bmatrix}
=
\begin{bmatrix}
\frac{1}{p} d\gamma_1 - \frac{f_1}{p} dp + \frac{t_2}{p} (p f_1 - \gamma_1) dD \\
\frac{k}{p} + \lambda) d\gamma_2 + \frac{\gamma_2}{p} dk - \frac{f_2}{p} dp + \frac{t_2}{p} (p f_2 - k\gamma_2) dD \\
X_2 d\gamma_2 - dK - dD
\end{bmatrix}. \] (3.54)

The second order condition for a constrained maximum, that the bordered Hessian matrix be negative definite, is met if the production function is assumed to have the normal properties (i.e. diminishing marginal physical productivity). Thus,
\[ |\Pi| = - \frac{1}{p} (p \gamma_2 f_{11}) > 0 \] (3.55)
if \( f_{11} < 0 \).
The optimal values of the endogenous variables, \( X_1, X_2 \) and \( \lambda \) can be expressed as functions of the exogenous variables such that

\[
X_1^* = X_1^* \left( \frac{p}{\rho}, \frac{\gamma_1}{\rho}, \frac{k \gamma_2}{\rho}, D, \overline{K} \right),
\]

\( (3.56) \)

\[
X_2^* = X_2^* \left( \frac{p}{\rho}, \frac{\gamma_1}{\rho}, \frac{k \gamma_2}{\rho}, D, \overline{K} \right), \text{ and}
\]

\( (3.57) \)

\[
\lambda^* = \lambda^* \left( \frac{p}{\rho}, \frac{\gamma_1}{\rho}, \frac{k \gamma_2}{\rho}, D, \overline{K} \right).
\]

\( (3.58) \)

Thus, the optimal values of the endogenous variables will be influenced by changes in the levels of the exogenous variables.

To investigate the impact of changes in the exogenous variables, including the availability of debt financing, on the demand for inputs, we can employ the system of total differentials shown in Equations (3.51) through (3.53). The impact of a change in debt availability on the demand for inputs can be seen by dividing this system by \( dD \) while assuming that all other exogenous variables remain unchanged. Writing the results in matrix form,

\[
\begin{bmatrix}
\frac{p}{\rho} f_{11} & \frac{p}{\rho} f_{12} & 0 \\
\frac{p}{\rho} f_{21} & \frac{p}{\rho} f_{22} & -\gamma_2 \\
0 & -\gamma_2 & 0
\end{bmatrix}
\begin{bmatrix}
\frac{dx_1}{d\rho} \\
\frac{dx_2}{d\rho} \\
\frac{d\lambda}{d\rho}
\end{bmatrix}
= \begin{bmatrix}
\frac{t}{\rho^2} (p f_{11} - \gamma_1) \\
\frac{t}{\rho^2} (p f_{22} - k \gamma_2) \\
-1
\end{bmatrix}.
\]

\( (3.59) \)

Given that the bordered Hessian matrix, \( |H| \) is identical to the Jacobian matrix, \( |J| \), by Cramer's rule,
The first order conditions for a maximum require that $p f_1$, the value of the marginal physical product of $X_1$, be equal to $\gamma_1$, the unit price of $X_1$. If those conditions hold, then $\frac{dx_1}{dD}$ is positive which means that an increase in debt availability will increase the demand for input $X_1$.

Also, by Cramer's rule,

$$\frac{dx_1}{dD} = \frac{1}{|J|} \begin{bmatrix} \frac{t}{\rho} (p f_1 - \gamma_1) & \frac{P}{\rho} f_{12} & 0 \\ \frac{t}{\rho} (p f_2 - k\gamma_2) & \frac{P}{\rho} f_{22} & -\gamma_2 \\ -1 & -\gamma_2 & 0 \end{bmatrix} \text{, or (3.60)}$$

$$\frac{dx_1}{dD} = -\frac{1}{|J|} \left( \frac{t}{\rho^2} \gamma_2^2 (p f_1 - \gamma_1) + \frac{P}{\rho} \gamma_2 f_{12} \right) \text{.} \quad (3.61)$$
The increased availability of debt will lead to an increase in the demand for $X_2$, the stock or capital input in the present model.

The final comparative static result involving a ceteris paribus change in the availability of debt financing,

$$\frac{d\lambda}{dD} = \frac{|J_3|}{|J|} \text{ or } \frac{d\lambda}{dD} = \frac{1}{|J|} \left\{ \gamma_2 \frac{P}{\rho} \left( f_{11} \frac{E}{\rho} (p f_2 - k Y_2) - f_{21} \frac{E}{\rho} (p f_1 - \gamma_1) \right) \right. \left. - \left( \frac{P}{\rho} (f_{11} f_{22} - f_{12}^2) \right) \right\},$$

will be negative assuming that the first order conditions for a maximum hold. This result is logical in that the greater availability of debt eases the constraint and lowers the shadow price of debt.

These results derive from the fact that the level of employment of $X_2$, because of the model specification, is dependent on the availability of money capital. As money capital becomes more freely available, the utilization of input $X_2$ rises. It is assumed that the cross-partial of input $X_1$ with respect to a change in input $X_2$ is positive, meaning that an increase in the use of $X_2$, ceteris paribus, raises the marginal value product of input $X_1$. Therefore, an increase in the utilization of $X_2$ results in a rise in the employment of $X_1$.

The model also demonstrates that other exogenous variables affect input demand as well, as shown in Table 3.1 below. For example, a change in the expected price of output, $p$, has a positive impact on the
Table 3.1. Summary of comparative static results

<table>
<thead>
<tr>
<th>Endog. var.</th>
<th>Exog. var.</th>
<th>( x_1 )</th>
<th>( x_2 )</th>
<th>( \lambda )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endog. var.</td>
<td>( x_1 )</td>
<td>( x_2 )</td>
<td>( \lambda )</td>
<td></td>
</tr>
</tbody>
</table>

\[
\begin{align*}
\rho & \quad \frac{1}{|J|} \left( \frac{f_1}{\rho} \gamma_2 \right)^2 = -\frac{f_1}{\rho f_{11}} > 0 & 0 & \frac{1}{|J|} \left( \frac{p \gamma_2}{\rho} (f_{21} f_1 - f_{11} f_2) \right) \\
\gamma_1 & \quad -\frac{1}{|J|} \left( \frac{\gamma_2}{\rho} \right) = \frac{1}{\rho f_{11}} < 0 & 0 & -\frac{1}{|J|} \left( \frac{p f_{21} \gamma_2}{\rho^2} \right) < 0 \\
\gamma_2 & \quad -\frac{1}{|J|} \left( \frac{p f_{12} \gamma_2 x_2}{\rho} \right) & \frac{1}{|J|} \left( \frac{p f_{11} \gamma_2 x_2}{\rho} \right) & \frac{1}{|J|} \left( \frac{p^2 x_2}{\rho^2} (f_{11} f_{22} - f_{12}^2) \right) \\
& \quad \text{not specified} & \text{not specified} & -\frac{1}{|J|} \left( \frac{p x_2 (f_{11} f_{22} - f_{12}^2)}{p f_{11}} \right) \\
& \quad \text{not specified} & \text{not specified} & + \frac{k}{\rho + \lambda} < 0
\end{align*}
\]
\[
D \frac{1}{|J|} \left\{ \frac{p}{\rho} \frac{f_{12}}{f_{11}} \right\} \\
= \left\{ \frac{t}{\rho p} (p f_1 - Y_1) \right\} \\
= \left\{ \frac{t}{\rho p} f_{11} \right\} > 0 \\
= \frac{f_{12}}{Y_2 f_{11}} > 0
\]

\[
K \frac{1}{|J|} \left( \frac{p}{\rho} \frac{f_{12} Y_2}{f_{22}} \right) \\
= - \frac{f_{12}}{f_{11} Y_2} > 0
\]
demand for input $X_1$ and on the value of the Lagrangian multiplier, $\lambda$. An increase in the price of output raises the value of the marginal product of $X_1$, and requires a greater employment of $X_1$ for the maintenance of equilibrium. An increase in the price of output likewise makes any scarcity of money capital that much more costly in terms of lost profit opportunities.

The impact of a change in the expected price of output on the employment of $X_2$ is shown to be zero. While this result may at first seem untenable, it must be remembered that the comparative static analysis deals with the values of the endogenous variables derived within the context of constrained maximization. Thus, the level of employment of input $X_2$ is contingent on the availability of money capital. The desired level of employment of $X_2$ may indeed be positively related to changes in the price of output, but the optimal level is still a function of the constraint. The value of the Lagrangian multiplier, already shown to be positively related to changes in the price of output, may provide a clue as to the relationship between the desired level of employment of input $X_2$ and the price of output. This multiplier can be interpreted as the value to the objective function of easing the money capital constraint. Because an easing of the constraint would allow a greater employment of input $X_2$, then the Lagrangian multiplier may also be interpreted as the value to the objective function of an increase in the number of units of $X_2$ employed. Because the change in $\lambda$ with respect to a change in the price of output is positive, it can be implied that changes in the desired level of employment of $X_2$ are also
positively related to changes in output price.

The impact of a change in the price of input $X_1$ on the demand for $X_1$ is negative. The rise in the price of $X_1$ requires a commensurate rise in its marginal value product to maintain equilibrium. Given an unchanging output price and diminishing marginal productivity of inputs, the only way to achieve the required increase is to cut back on the employment of $X_1$. Similarly, the impact of a change in the unit price of $X_1$ on the Lagrangian multiplier is negative. The decrease in the level of $X_1$ employment brought about by the rise in its unit price would lead to a reduction in the employment of $X_2$. The relationship between the two inputs in production is such that changes in the usage of $X_1$ also affect the marginal physical productivity of input $X_2$. This relationship is positive (i.e. $f_{21} > 0$) so that a reduction in $X_1$ employment leads to a decrease in the marginal physical product of $X_2$ and a subsequent decrease in $X_2$ employment. Thus, any constraint on the employment of $X_2$ is rendered less costly in terms of forgone profit. The direct impact of a change in the unit price of $X_1$ on the employment of input $X_2$ is zero. The employment of $X_2$ is, as argued previously, contingent on the money capital constraint and the price of input $X_1$ is not present in that constraint.

A change in $Y_2$, the unit price of input $X_2$, has a negative impact on the demand for both $X_1$ and $X_2$. The unit price of $X_2$ is defined as the acquisition price of a capital asset. An increase in $Y_2$ would, ceteris paribus, reduce the level of employment of both $X_2$ and $X_1$. The reduction in the utilization of $X_2$ comes about because such a
reduction, with its positive impact on productivity, offers the only way to maintain equilibrium in the face of a rise in $V_2$. The employment of $X_1$ falls to compensate for the drop in productivity visited upon input $X_1$ by a decrease in the employment of $X_2$. The impact of a change in the price of $X_2$ on the value of the Lagrangian constraint is complicated by the fact that two opposing effects are operating simultaneously. As the price of $X_2$ rises, less of the input will be utilized, thus decreasing the value of scarce money capital and of the Lagrangian multiplier. On the other hand, a rise in the price of $X_2$ makes the constraint more severe for any given level of $X_2$ used in production. The net impact will depend on the relative strengths of the two opposing effects.

The impact on the endogenous variables of a change in the amount of available debt financing has already been described in some detail. A change in the amount of equity capital available will have positive impacts on the demands for $X_1$ and $X_2$, respectively, and a negative impact on the value of the Lagrangian multiplier. Ceteris paribus, an increase in the availability of equity will raise the utilization of input $X_2$. This occurrence will lead to an increase in the desired level of employment of input $X_1$. An increase in equity will, of course, lessen the opportunity cost of money capital because that opportunity cost is inversely related to the availability of money capital.

**Implications for Land Prices**

These comparative static results suggest the impact of greater debt availability on the demand for inputs by an individual...
decision maker. The market demand function for an input is obtained by summing the demand functions of the individual decision makers. Given a more general model specification, the greater availability of debt through a higher loan-to-value ratio would be expected to have a differential impact on decision makers. Some would have no capital constraint to begin with while others may already have been operating at a self-imposed debt limit. The remainder, however, would expand their demand for inputs as their source of money capital grew. With the present model specification, all decision makers are assumed to respond positively to changes in the availability of debt. Thus, the input demand curves for each individual as well as the aggregate demand curve would shift rightward with an increase in the availability of debt.

Up to this point, the discussion has centered around the relationship between input demand and debt availability given the prices of those inputs. The focus of the empirical model, however, will be the explanation of variability in the price of one input, namely, farm land.

The qualitative demand functions derived earlier suggest the relationship between the demand for an input and the price of that input. Holding constant all of the other variables that have been shown to affect the demand for an input, the relationship between input demand and input price is reflected in the locus of points that constitutes that input's demand curve. At any selected input price, the demand curve shows the level of input use that, ceteris paribus,
maximizes the objective function. Similarly, at any selected input level, the demand curve shows the maximum price per unit that the decision maker would be willing to pay.

If the demand functions for $X_1$ and $X_2$ are inverted to solve for price rather than quantity demanded, the quantities of $X_1$ and $X_2$ rather than their prices are regarded as being exogenously determined. The demand curves for $X_1$ or $X_2$ are not altered in any way, either in slope or location. But, instead of assuming that the decision maker adjusts the quantity he purchases to a given price, the inverse demand function assumes that the buyer adjusts his bid price for a given quantity offered for sale so as to achieve a point on his demand curve.

Thus, if

$$x_1^* = h_1 \left( \frac{\gamma_1}{\rho} \right)$$  \hspace{1cm} (3.66)

and

$$x_2^* = h_2 \left( \frac{k\gamma_2}{\rho} \right) ,$$  \hspace{1cm} (3.67)

then

$$\frac{\gamma_1^*}{\rho} = g_1(x_1^*)$$  \hspace{1cm} (3.68)

and

$$\frac{k\gamma_2^*}{\rho} = g_2(x_2^*) .$$  \hspace{1cm} (3.69)

Again, assuming that $k = \rho$, then

$$\gamma_2^* = g_2(x_2^*) .$$  \hspace{1cm} (3.70)

The comparative statistics results presented in Table 3.1 above reflected the case where quantities of inputs $X_1$ and $X_2$ were the endogenous variable and their prices, the exogenous variables. Because
most of the comparative static results involve a shift in the demand curve, specifying the price of either input as endogenous and the quantity as exogenous makes no difference. For example, the impact of a change in the price of output on the employment of $X_1$, as shown in Table 3.1, is positive. This result arises from a shift in the demand curve for $X_1$ (i.e. increase in the price of output increases the value of the input's marginal product at every level of marginal physical product). The assumption that $X_1$, rather than $Y_1$, is exogenous changes nothing in the relationship between changes in the price of output and movement of the demand curve. Thus, the impact of a change in output price on the price of $X_1$, $\frac{dY_1}{dp}$, is also positive. The same logic applies to the other exogenous variables in the model. Where the impact of a change in any other variable on the demand for $X_1$ is positive (negative), that impact is likewise positive (negative) on the change in the price of $X_1$. This is, of course, true of $X_2$ as well.

The comparative static result that reflects movement along the demand curves for $X_1$ or $X_2$, that is, $\frac{dX_1}{dY_1}$ and $\frac{dX_2}{dY_2}$ remain negative with the reversal of the roles of price and quantity. This result must be true since the demand curves for both inputs are downward sloping regardless of whether price or quantity is exogenous. When quantity is exogenous and when, ceteris paribus, it changes, the decision maker must adjust his bid price to remain on his demand curve. If a larger quantity is offered for sale it can only be employed by the decision maker at a lower unit price since he will encounter diminishing marginal
returns in using the additional quantity in production.

The comparative static results, however, have not considered the role of the supply of the input in determining the ultimate change in the endogenous variables. If the supply of the input were perfectly elastic, the full impact of a rightward shift in the demand curve would be on quantity. On the other hand, a perfectly inelastic supply curve would yield a new equilibrium at the same quantity, but at a higher price. A positively sloped, but not perfectly inelastic, supply curve would produce a new equilibrium that reflected increases in both price and quantity sold.

If input $x_2$ refers to owned farm land, the conditions under which it is supplied are probably best approximated by an upward sloping supply curve. Although the absolute amount of land that is available for use at any point in time is fixed, the amount that is available for sale will vary with the price offered. Thus, one would expect the new equilibrium resulting from a rightward shift in demand to reflect both an increased quantity and a higher price. In other words, an increase in demand for land brought about by an increase in the availability of debt would theoretically lead to the purchase of additional land, but at a higher price.

Summary

Chapter III has presented a model of firm behavior under the condition of money capital scarcity. The objective function in this model maximizes the discounted value of profits accruing to the owners of the firm. The discount factor reflects the owner's attitude
toward risk, risk in this case being represented by the variance in returns to the owner. The variance in returns and the discount rate have been shown to be a function of the proportion of debt in the firm's financial structure. As the proportion of debt to equity increases, ceteris paribus, so does the variance in expected returns to the owner.

The objective function is constrained by the availability of money capital which is defined as the purchasing power necessary to acquire capital assets and maintain a given level of working capital. The constraint on money capital availability is an important concern to the decision maker in that it has an impact on the size of the firm and on the selection of capital inputs employed by the firm. If money capital becomes more freely available to a firm through an increase in equity funding or through an increase in debt financing, there is likely to be a change in the demand for productive inputs. This change of demand for inputs is likely, in turn, to influence the price of inputs.

The model presented in this chapter, thus, makes explicit the link between production decisions and financial decisions. It remains for the empirical model which will be presented in Chapter V to test the relationship between money capital availability and the demand for and price paid for agricultural land. Both the direction and strength of this relationship have been suggested by the comparative static analysis of the model and the results of earlier research reviewed in Chapter II.
CHAPTER IV. THE DATA SET

The model presented in Chapter III has demonstrated a theoretical basis for the relationship between down-payment terms and the price of agricultural land. It is the purpose of this chapter to identify the data needed to test specific hypotheses about that relationship.

The most obvious data requirements are observations on sale prices for farm land transactions and the corresponding down payments made as a part of those transactions. Selling price and down-payment percentage represent, respectively, the dependent and independent variables in the relationship between land price and debt availability conjectured by the model in Chapter III.

However, as the theoretical model dictates, and as common sense would suggest, the down-payment percentage is not the only variable to influence the sale price of farm land. An array of other variables has been shown, in the context of the theoretical model, to have an impact on the sale price. Thus, the data requirements must be expanded to include those variables as well. As an example, while the purpose of this study is not to examine the impact of the price of agricultural output on the prices paid for farm land, some measure of the price of agricultural output has been shown logically to belong to the set of variables that affect the demand for farm land and must therefore be included. Other variables, likewise shown by economic theory to be important, may have additional uses. The impact of the down-payment requirement on sale price may vary with changes in the values of other pertinent variables. For example, the theoretical model implies that
the initial equity position of a decision maker may have an impact on his or her demand for capital inputs. Data which describe the equity position of the buyer of farm land would thus be required if a hypothesis regarding the affect of initial equity position were to be tested.

A further requirement regards the type of data to be used. As discussed in the critique of existing literature, most land valuation studies are conducted using aggregate data. That data prevent the examination of the impact of certain key variables. Aggregation of data tends to eliminate much of the variation in both the dependent and independent variables making it difficult to detect hypothesized relationships. Often, the most compelling explanatory variable in aggregated data is a trend which arises from a source outside the variables of interest. While trends are important in their own right, they tend to obscure the true relationship between dependent and independent variables. The type of data needed for examining the problems of interest to this study is micro data. One available set of micro data consists of 182 observations of farm real estate sales made in the state of Iowa over the years 1969 through 1979. These data were collected during the period 1977-1979 as part of a class assignment for an undergraduate course in farm appraisal taught at Iowa State University.

Although the observations span the 11 years from 1969 through 1979, they are concentrated in a fewer number of years, as shown in Table 4.1 below. The four years, 1976 through 1979, account for nearly
Table 4.1. Distribution of sale observations by type of financing and by year of sale

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>Cash</th>
<th>Contract</th>
<th>Mortgage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969</td>
<td>1</td>
<td>1</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1970</td>
<td>1</td>
<td>--</td>
<td>--</td>
<td>1</td>
</tr>
<tr>
<td>1971</td>
<td>1</td>
<td>--</td>
<td>--</td>
<td>1</td>
</tr>
<tr>
<td>1972</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>--</td>
</tr>
<tr>
<td>1973</td>
<td>4</td>
<td>--</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>1974</td>
<td>8</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>1975</td>
<td>12</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>1976</td>
<td>24</td>
<td>3</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>1977</td>
<td>42</td>
<td>9</td>
<td>19</td>
<td>14</td>
</tr>
<tr>
<td>1978</td>
<td>51</td>
<td>13</td>
<td>20</td>
<td>18</td>
</tr>
<tr>
<td>1979</td>
<td>32</td>
<td>6</td>
<td>12</td>
<td>14</td>
</tr>
</tbody>
</table>

85 percent of the observations.

Even though the observations are representative of sales in the Iowa farm land market over a number of years, they can also be considered cross-sectional in that they are representative of sales across location and quality of land and type of buyer. Since the primary focus of this study is on the cross-sectional dimension, the data are treated as such, the "point in time" being stretched beyond
a single calendar year. To counter the affects of a rising price level over the time period, all prices are deflated by the implicit GNP price deflator. The potential for structural change is mitigated by the relatively short length of the time series.

Basic information recorded for each sale includes date of sale, price paid, the names of buyer and seller, the number of acres in the sale tract, and the location of the tract (see Appendix A for a copy of the survey form). Data on financing terms collected for each sale include the type of financing, whether contract or mortgage; the dollar amount of down payment; the interest rate on the contract or mortgage; the term of the loan, and the payment pattern, whether periodic or balloon, or a combination of the two. Land contracts financed 38 percent of all sample sales over all years, although the proportion varied, excluding the years before 1975, from 33 percent in 1975 to 45 percent in 1977. Some 39 percent of all sales in all years were mortgage-financed. This percentage ranged, again excluding 1969 through 1974, from a low of 33 percent in 1975 and 1977 to a high of 50 percent in 1976. The amount of down payment as a percentage of purchase price averaged 15.8 percent for all years and both types of financing. Table 4.2 presents a detailed breakdown by year and type of financing. The average interest rate and term of loan were 7.68 percent and 14.2 years, respectively, for contract sales and 8.84 percent and 28.1 years, respectively, for mortgage sales.
Table 4.2. Average down-payment percentage by type of financing and year of sale, cash sales excluded

<table>
<thead>
<tr>
<th>Year</th>
<th>Type of financing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contract</td>
</tr>
<tr>
<td>1969</td>
<td>--%</td>
</tr>
<tr>
<td>1970</td>
<td>--</td>
</tr>
<tr>
<td>1971</td>
<td>--</td>
</tr>
<tr>
<td>1972</td>
<td>3</td>
</tr>
<tr>
<td>1973</td>
<td>20</td>
</tr>
<tr>
<td>1974</td>
<td>20</td>
</tr>
<tr>
<td>1975</td>
<td>17</td>
</tr>
<tr>
<td>1976</td>
<td>14</td>
</tr>
<tr>
<td>1977</td>
<td>20</td>
</tr>
<tr>
<td>1978</td>
<td>18</td>
</tr>
<tr>
<td>1979</td>
<td>17</td>
</tr>
</tbody>
</table>

The data set also includes two important groups of variables describing, respectively, the characteristics of the farm sold and the characteristics of the buyer. The farm is described in terms of its location, its productivity, and the buildings and improvements on the property. More specifically, location includes the distance, in miles, of the tract from the nearest supply or marketing center, and the surface of the road accessing the tract. The farm's productivity is characterized by the number of tillable acres, acres in permanent pasture and waste acres, the total farm average corn suitability
rating (CSR), the average CSR for the tillable acres and the average corn yield, both for total and for tillable acres. Buildings are characterized by their condition (e.g. from obsolete to excellent) while improvements refer to the existence of terraces or tilling. Any specialized facilities such as livestock confinement facilities or Harvestore silos are also noted.

Buyers are characterized with respect to form of ownership, owner-operator versus landlord; and type of ownership organization, single proprietorship, partnership, or corporation. The size of the buyer's operation before the land acquisition is reflected in the number of acres owned and rented prior to the current purchase; the number, horsepower, and age of tractors owned; and the number and age of self-propelled combines owned.

The distance from the home farm to the new acquisition is also indicated, as well as a number of personal characteristics of the buyer. These include the number of years the owner-operator has been farming, the amount of off-farm income earned by the owner-operator and his family, and the total net worth of the owner-operator and family. For the latter variables, the buyer indicated the range in which his income and net worth, respectively, fell.

Other data, necessary for the econometric model, are not found on the survey forms, but are available from other sources. Corn prices by year and by price reporting district in Iowa are obtained from state extension service publications. The annual *Iowa Land Value Survey*, giving a county breakdown of farm land values, provides data for
estimating expected capital gains to farm land and the wealth of land buyers in the sample.
CHAPTER V. THE ECONOMETRIC MODEL

The purpose of this chapter is to construct an econometric model capable of testing certain hypotheses about the impact of the down-payment percentage on the price paid for agricultural land. The issues of primary importance are first, what form the model should take and second, what variables should be included in the model. Economic theory, especially in the form of the theoretical model presented in Chapter III above, provides the initial guidance in these matters. Data availability and the limitation of econometric techniques place further restrictions on the selection process. Finally, the statistical results of the estimation will help determine whether the model can be deemed an accurate reflection of the underlying relationship between the down-payment percentage and the price paid for farm land.

The chapter will proceed with a restatement of the general hypothesis of this study. The next section will describe the form of the econometric model and the variables to be included in the estimation of the regression parameters. Following that discussion will be the presentation of the parameter estimates and tests of their statistical significance. The chapter will conclude with the calculation of elasticity coefficients and their interpretation.

The General Hypothesis: A Restatement

Chapter III explained how and why the existence of a money capital constraint can affect the demand for a productive asset. Money capital scarcity imposes an additional cost, albeit an opportunity cost, on the
acquisition of a productive asset. Recalling Equation (3.47) from Chapter III,

\[ \frac{1}{\rho} p f_2 - \lambda \gamma_2 = \gamma_2 \]  

(5.1)

the element \( \lambda \gamma_2 \) on the left-hand side represents this additional cost. As long as \( \lambda \) is positive, then money capital is scarce. As \( \lambda \) varies, \textit{ceteris paribus}, the equilibrium condition for input demand also changes.

A comparison of the equilibrium level of use of an input that requires an investment in money capital with one that does not would show that the optimal solution requires the return to the former to "cover the cost" of the requisite investment in scarce money capital. The extent of this cost would depend on the degree of money capital scarcity. The more (less) severe the scarcity, the greater (lesser) the cost. Assuming the price of capital inputs to be unchanging, the severity of the constraint for a particular level of capital input use would depend on the availability of money capital in the form of debt or equity capital. In other words, the severity of the constraint would be reflected in the firm's leverage ratio, a low ratio reflecting a more severe constraint and a high ratio, a less severe constraint.

The total money capital requirement for the acquisition of farm land is the product of the price per acre and the number of acres acquired. The sources of money capital available to the land buyer include his own equity and the debt financing extended by the mortgage lender or the land seller. Assuming that the land buyer has fixed equity capital, the total amount of money capital he or she has available for land
purchase is determined by the amount he can borrow which in turn is reflected in the size of the down payment he must make.

Therefore, the greater (lesser) availability of money capital through smaller (larger) required down payment can be expected, under certain conditions, to have an impact on the demand for farm land. These conditions are, first, that money capital in general be scarce and second, that an individual not be constrained internally from adding debt to his financial structure. The impact on the demand for farm land will, depending on the conditions of supply, have an impact on the price of farm land.

The nature and intensity of this impact might be expected to vary across buyers with changes in other factors. The factor of particular interest to this study is the net wealth or equity of the land buyer at the time he makes the farm land purchase.

_Ceteris paribus_, the buyer with the highest equity would be the least levered, have the smallest discount rate, \( \rho \), and again, as seen in Equation (5.1), attain equilibrium at a higher input price, \( \gamma_2 \).

\[
\frac{1}{\rho} p f_2 = \gamma_2 (1 + \lambda)
\]  

(5.2)

If, instead of varying leverage ratios and discount rates, all buyers are assumed to have the same ratio and rate but different amounts of equity, then _ceteris paribus_, those with the highest level of equity will have the greatest total assets. And, if over the range of farm size normally encountered, size as measured by total assets is positively related to productivity, \( f_2 \), then buyers with the largest
equity and greatest size still can attain equilibrium, according to Equation (5.2), at a higher input price, \( V_2 \). Thus, the direct impact of wealth on the demand for land is hypothesized to be positive. The direct impact of wealth on the price of farm land is likewise hypothesized to be positive, the buyer with the greater wealth having the greater bidding potential in the market for farm land [Harris and Nehring, 1976].

Even if large scale offers no advantages in terms of productivity, the level of wealth, as measured by equity level can influence the value of the Lagrangian constraint, \( \lambda \), and in the context of Equation (5.2) affect the demand for a productive asset. At higher levels of equity, *ceteris paribus*, the value of \( \lambda \) would be smaller and the equality expressed in Equation (5.2) would be achieved at a higher price for input \( X_2 \).

We cannot test these hypotheses about the behavior of the buyers directly. That is, we have no way of knowing the nature and degree of substitution between down-payment percentage and price for an individual buyer in our sample. What we do have is a series of sale prices and accompanying information on the terms of sale and the characteristics of the buyer. We assume that these sales are made under competitive conditions which would imply that the highest bidder gets the land. If we can hold constant certain characteristics of the land, the buyer, and the terms of financing, then we can look for a relationship between sale price and down-payment percentage.
Model Formulation

The proposed econometric model will take the form of a multiple regression model. The objective function and constraint, as shown in Chapter III, can be transformed through total differentiation into a system of equations in which each equation is linear with respect to the coefficients that are to be estimated. Linear regression, thus, is a suitable analytical technique.

The variables denoted by the theoretical model as having a causal relationship to the price paid for agricultural land can be grouped into three categories. There are, first, those variables that determine the expected net revenues to be gained from the purchase of farm land. Second, there are the variables that reflect the financial structure of the decision maker's business at the time the purchase was made and third, there are the variables that describe the terms under which the land purchase was financed. There are, as well, some interactions between these categories. The problem then is to select from the data at hand the proper or best expression of these variables for inclusion in the multiple regression model.

Expected net revenue

The variables in the first category, expected net revenue, include the expected price of agricultural output, the expected relative productivity of land and the expected cost of the land input.

As a measure of the expected price of agricultural output, the model will use the expected price of corn per bushel in the six price reporting districts in the state of Iowa. Because an expected value is
not observable, it will be necessary to create such a variable. The expected price of corn can be deemed a forecasted price. Thus, the expected price of corn will be derived from a simple forecasting model. In selecting a forecasting method for this variable, the purpose is not to strive for accuracy per se, but to attempt to replicate the behavior of the farm land buyer in the sample data. The criterion for a good forecast in this case is the goodness-of-fit achieved by the variable in the regression equation. With this criterion in mind, the corn price was forecasted using a simple five year moving average. While the average corn price in Iowa in dollars per bushel was available for all years, a breakdown by price reporting district was available only for the time period September 1974 through August 1978. To extend the district breakdown back the required number of years, a ratio of the district average to the state-wide average was calculated for each price reporting district for each year the data was available. These yearly ratios were averaged and that average was applied to the time period before September 1974 to find the average corn price in each of the price reporting districts. It should be noted that the intrastate differences in corn price reflect varying local supply and demand conditions as well as distance and accessibility to regional and national markets. While some of the factors that cause these differences vary from year to year, others, such as distance to major markets, location of processing plants or livestock production areas, and availability of rail and barge transportation change only gradually. Thus, the use of the calculated ratio to extend the district price series back several years was
considered an acceptable technique. Once the district prices were estimated for years prior to 1974, a price forecast, which represents the expected price, was calculated using a five year moving average for each year in the sample and for each price reporting district. The results are shown in Table 5.1.

In the comparative static analysis of Chapter III, the relative productivity of the input did not emerge as an exogenous variable because it is assumed that the units of input are of identical quality. In reality, however, parcels of farm land are normally quite variable as to quality. Thus, in order to maintain the assumption of the theoretical model, a measure of productivity must be introduced. This measure helps to establish the ceteris paribus conditions necessary for assessing the relationship between the sale price of farm land and the variables of special interest to this study.

Several measures of the productivity of the sample tracts are available. The proportion of tillable to total acres is known as are the average corn suitability rating and the average corn yield in bushels per acre for total acres and tillable acres, respectively. The best candidate for a measure of productivity would appear to be the average corn yield per acre for all acres in the tract. Yield is a better reflection of actual productivity than the suitability rating which expresses potential productivity in light of assumed climatic conditions. Yield on total acres will be used instead of yield on tillable acres because the per-acre sale price, which serves as the dependent variable in the multiple regression, is itself an "average" price for all acres.
Table 5.1. Five-year moving average corn price in Iowa, by price reporting district, and five-year period

<table>
<thead>
<tr>
<th>Five-year period</th>
<th>North-west</th>
<th>North-central</th>
<th>North-east</th>
<th>South-west</th>
<th>South-central</th>
<th>South-east</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964-68</td>
<td>$1.08</td>
<td>$1.09</td>
<td>$1.10</td>
<td>$1.08</td>
<td>$1.10</td>
<td>$1.13</td>
</tr>
<tr>
<td>1965-69</td>
<td>1.08</td>
<td>1.09</td>
<td>1.10</td>
<td>1.08</td>
<td>1.10</td>
<td>1.13</td>
</tr>
<tr>
<td>1966-70</td>
<td>1.08</td>
<td>1.09</td>
<td>1.09</td>
<td>1.08</td>
<td>1.09</td>
<td>1.12</td>
</tr>
<tr>
<td>1967-71</td>
<td>1.12</td>
<td>1.12</td>
<td>1.13</td>
<td>1.12</td>
<td>1.13</td>
<td>1.16</td>
</tr>
<tr>
<td>1968-72</td>
<td>1.09</td>
<td>1.09</td>
<td>1.10</td>
<td>1.09</td>
<td>1.10</td>
<td>1.13</td>
</tr>
<tr>
<td>1969-73</td>
<td>1.18</td>
<td>1.19</td>
<td>1.19</td>
<td>1.18</td>
<td>1.19</td>
<td>1.23</td>
</tr>
<tr>
<td>1970-74</td>
<td>1.46</td>
<td>1.47</td>
<td>1.47</td>
<td>1.46</td>
<td>1.47</td>
<td>1.52</td>
</tr>
<tr>
<td>1971-75</td>
<td>1.83</td>
<td>1.84</td>
<td>1.85</td>
<td>1.82</td>
<td>1.84</td>
<td>1.89</td>
</tr>
<tr>
<td>1972-76</td>
<td>2.07</td>
<td>2.08</td>
<td>2.09</td>
<td>2.06</td>
<td>2.08</td>
<td>2.14</td>
</tr>
<tr>
<td>1973-77</td>
<td>2.32</td>
<td>2.31</td>
<td>2.32</td>
<td>2.28</td>
<td>2.30</td>
<td>2.37</td>
</tr>
<tr>
<td>1974-78</td>
<td>2.40</td>
<td>2.40</td>
<td>2.41</td>
<td>2.37</td>
<td>2.40</td>
<td>2.46</td>
</tr>
</tbody>
</table>
in the tract.

Given the expected price of corn per bushel and the expected yield in bushels per acre, the variable, expected gross returns per acre can be calculated as the product of price and yield. The expected sign of the variable in the multiple regression analysis is positive, the greater the expected gross return, the greater the sale price per acre.

While this expression for gross returns per acre is valid for the period immediately following the acquisition of the land, it does not capture expectations regarding future periods. That is, while the gross return variable may be a good measure of current returns it does not measure expected future changes in those returns. What is needed is a variable that describes the expected growth rate in real gross returns. Real gross returns to farm land can vary with a change in the productivity of farm land or a change in the price of output. A good description of the change in these returns might be provided by a data series on average per acre cash rents for farm land. Such a series is not readily available for several reasons, one of which is the widespread use of crop-share leases rather than cash leases in the rental of farm land in Iowa. A data series that is available, however, is the average value per acre of Iowa farm land and buildings, by crop reporting district. The land values appearing in these data series are based on a survey of real estate brokers. Land value is related to land rent through the standard valuation formula where

\[ V = \frac{R}{i}. \] (5.3)
If rent can be equated to net returns, \( R \), then land value, \( V \), can be seen as a function of rent and the discount rate, \( i \). Changes in the returns to farm land should be reflected in both the per acre cash rents paid for land and in the per acre selling price of farm land. The variable of interest to this research, the expected rate of change in the returns to farm land, can thus be viewed as a function of past rates of change in the value of farm land. More specifically, the expected rate of change in returns to farm land for any given year is calculated as the average annual percentage change in the real value of farm land for the previous five years. The real value of farm land was derived by deflating the nominal land value data series by the implicit GNP price deflator published by the U.S. Department of Commerce, 1972 = 100. This variable is essentially a measure of real capital gains to farm land. The impact of capital gains on land values has been examined by Crowley [1974] and Plaxico and Kletke [1979]. These authors modify the traditional land valuation formula to include expected capital gains as a return to ownership. Expectations of capital gains would thus raise the value of farm land. The question as to how capital gains arise and why they achieve the magnitudes they do has been studied by Melichar [1979] and Reinsel and Reinsel [1979] among others. Capital gains to farm land arise from expectations of growth in the current return to land [Melichar, 1979, p. 1089]. In the present model, past rates of real capital gain are thus used to measure expectations regarding growth in current returns. Table 5.2 below presents these expected rates of change by year and by crop reporting district in Iowa.
Table 5.2. Five-year moving average of real rate of growth in the value of farm land in Iowa, by crop reporting district and five-year period

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>State-wide average</td>
<td>-4.5%</td>
<td>-0.8%</td>
<td>6.1%</td>
<td>10.5%</td>
<td>27.4%</td>
<td>33.1%</td>
<td>22.1%</td>
<td>16.5%</td>
</tr>
<tr>
<td>Northwest</td>
<td>-6.0</td>
<td>-1.2</td>
<td>7.1</td>
<td>11.2</td>
<td>30.0</td>
<td>38.1</td>
<td>24.1</td>
<td>17.5</td>
</tr>
<tr>
<td>North Central</td>
<td>-5.8</td>
<td>-1.7</td>
<td>7.5</td>
<td>12.8</td>
<td>38.0</td>
<td>43.9</td>
<td>27.3</td>
<td>18.8</td>
</tr>
<tr>
<td>Northeast</td>
<td>-3.6</td>
<td>-0.9</td>
<td>6.6</td>
<td>10.4</td>
<td>26.7</td>
<td>35.0</td>
<td>23.1</td>
<td>18.6</td>
</tr>
<tr>
<td>West Central</td>
<td>-5.8</td>
<td>-1.6</td>
<td>4.3</td>
<td>8.6</td>
<td>26.4</td>
<td>32.6</td>
<td>23.5</td>
<td>18.9</td>
</tr>
<tr>
<td>Central</td>
<td>-5.6</td>
<td>-2.2</td>
<td>5.8</td>
<td>10.1</td>
<td>32.0</td>
<td>40.4</td>
<td>28.6</td>
<td>17.3</td>
</tr>
<tr>
<td>East Central</td>
<td>-4.5</td>
<td>0.0</td>
<td>7.6</td>
<td>23.0</td>
<td>30.1</td>
<td>21.9</td>
<td>18.1</td>
<td></td>
</tr>
<tr>
<td>Southwest</td>
<td>-2.3</td>
<td>1.1</td>
<td>5.0</td>
<td>6.7</td>
<td>14.7</td>
<td>19.7</td>
<td>14.8</td>
<td>15.4</td>
</tr>
<tr>
<td>South Central</td>
<td>0.4</td>
<td>0.6</td>
<td>6.1</td>
<td>11.9</td>
<td>12.9</td>
<td>17.9</td>
<td>14.9</td>
<td>10.3</td>
</tr>
<tr>
<td>Southeast</td>
<td>-3.5</td>
<td>0.2</td>
<td>6.6</td>
<td>15.7</td>
<td>29.3</td>
<td>28.2</td>
<td>18.8</td>
<td>10.2</td>
</tr>
</tbody>
</table>
As with the gross returns variable, the hypothesized sign of the growth rate variable in the multiple regression analysis is positive. The greater the expected rate of growth in the return to farm land, the greater would be the price paid for that land.

In the comparative static analysis of Chapter III, input price appeared as an exogenous variable while the quantity of input demanded appeared as an endogenous variable. In the empirical model, land price is treated as the dependent variable so it will not also appear as an explanatory variable. The relationship between land price and quantity demanded, as explained previously, traces the demand curve for farm land. The empirical model is designed to predict the price paid for the land input given that a certain quantity has been demanded or purchased.

Financial structure

The second category of variables is that which describes the financial structure of the land buyer's firm. Optimal financial structure plays a limited role in the model developed in this paper because of the assumption that the debt level of the firm is exogenously determined. Given the additional assumption of fixed equity, it follows that the firm's leverage ratio is likewise exogenously determined. Since the firm's capitalization rate is a function in part, of its leverage ratio, that too will vary with the availability of debt. As a consequence, the firm has no independent demand for debt. Furthermore, in the context of the model, the capitalization rate plays no role, across different buyers, in determining the amount of debt they will incur in buying land.
On the other hand, the money capital constraint plays a major role in the model. The availability of money capital affects the demand for an asset and thus the price that will be paid for that asset. Money capital availability is, in turn, a reflection of the debt and equity availability to the firm. The availability of debt will depend on the willingness of lenders to continue lending and of borrowers to continue borrowing. The willingness to continue lending or borrowing, respectively, can be seen to depend on, among other things, the extent of the borrower's equity, or more precisely, the amount of equity relative to debt.

Although the data available for this study do not describe both the debt and equity position of land buyers, they do note the equity or net worth of the buyer at the time of the land purchase. Buyers indicated into which of the following five ranges, $0 to $50,000; $50,001 to $100,000; $100,001 to $150,000; $150,001 to $200,000; or $200,001 and above, their net worth fell. This variable offers some promise as a measure of the financial means of the firm at the time it purchased the land. It also, however, presents some problems. In the first place, only 73 of the 186 survey forms included the net worth information, leaving the problem of how to deal with missing observations. This problem was made particularly acute by the fact that the net worth variable is discontinuous and could not be easily and reliably related to other variables in the data set with which it may have been correlated. The second and probably more serious problem is that the dollar ranges of the five net worth categories are not able to discriminate well
among the net worths of the land buyers in the sample. Fully 55 percent of those buyers who responded to the net worth question indicated that their net worth was greater than $200,000 at the time they purchased the subject tract.

In an effort to regain some of the missing observations in the net worth category, a procedure was used to estimate the categories of some of the observations where it had not been reported. It was assumed that the net worth category of the buyer at the time he purchased the land would be related to the size of his land holdings at the time of the purchase. For observations where the number of acres owned at the time of purchase was reported, a dollar value of acres owned was calculated by multiplying the acres owned by the county average land value (deflated) for the year in which the purchase was made. The relationship between this "gross worth" measure and net worth was estimated by regressing the mid-point of the net worth category (deflated) on the value of "gross wealth". The mid-point chosen for the open-ended category five was $500,000. While this procedure yielded 49 more observations, increasing the total to 122, it only exacerbated the problem of the distribution of observations among net worth categories. In the augmented data set, 66 percent of the observations fell into the top category. Furthermore, the deflating process caused all but one of the observations originally in category 4 to drop to category 3.

An alternative to using the net worth categories was to use the calculated "gross worth" figure itself as a proxy for net worth. The advantages of this alternative are several. First, 113 out of 186
observations indicated a response on acres owned, some 40 more than had indicated a net worth category. Second, the variable is continuous, making it possible to estimate a slope parameter rather than a shift in intercept, which is all that is possible with the use of net worth categories.

Use of the value of acres owned as a proxy for net worth has its disadvantages as well. Farm land, although the dominant asset on a farmer's balance sheet is not the only source of net worth. Non-real estate and financial assets also exist and contribute to the net worth of farm operators. The balance sheet of the farming sector [USDA] shows that for the United States as a whole, for the years 1970-79, the proportion of the value of total assets of farmers accounted for by the value of real estate averaged 70.7 percent and ranged from 67.7 percent in 1977 to 73.7 percent in 1977. These statistics underscore the importance of real estate assets to farmers' balance sheets. It may be reasonable to assume that the value of other types of assets, both real and financial would be proportional to the value of real estate assets. This assumption is all the more reasonable given that virtually all of the buyers in the sample are owner-operators and not landlords or non-farm investors. Thus, they are more likely to hold similar types of assets.

A second problem with using the value of acres owned is that the per-acre value used in the calculation is a county-wide average. Thus, not only is the calculated value of acres owned a proxy variable for net worth, it is itself only an estimate of the true value of owned land.
Within-county differences in farm land value are influenced by factors such as productivity, proximity to markets and nearness to urban areas. The extent of intra-county differences in land values in the present sample can only be conjectured. The fact that none of the counties represented in the sample is heavily urban, however, removes one of the potential causes of intra-county variance in land values.

A third problem is that the proxy variable is a measure of total asset value, not owner's equity in that asset. As such, it does not capture the variation in financial leverage among buyers. While knowledge of this variation would make for a more compelling conceptual argument with respect to the impact of buyer wealth on farm land price, existing data sets which, by design include only those buyers successful in obtaining financing, may show such a limited range of buyer leverage as to render it a relatively unimportant factor, empirically. Among buyers represented by the data set, therefore, a gross measure of wealth may be as appropriate as a net measure.

Despite the problems associated with using the value of acres owned as a proxy for net worth, it appears superior to the net worth categories, especially in its ability to discriminate among the wealth of the buyers in the sample. The hypothesis regarding net worth and thus its proxy is that a greater net worth, *ceteris paribus*, means a less severe money capital constraint and that a buyer with a larger net worth could afford to pay a higher price for land. Assuming then that a particular sale tract goes to the highest bidder, the impact of net worth on price will be positive.
The variable enters the multiple regression equation on a per acre basis. That is, the value of acres owned is divided by the number of acres being purchased. This procedure relates the proxy measure of net worth to the size of the land purchase. The availability of money capital in absolute terms does not fully explain its impact on the demand for an asset. It is the money capital availability compared to the money capital required, a relative concept, that is assumed to have the greatest explanatory power.

In addition to indicating the relative wealth that buyers have at the time of purchase, it may be useful to indicate also the absolute size of the purchase. The size of the purchase in terms of acres has been found to be a significant variable in other land value studies [VanHove, 1978; Herr, 1975; Klinefelter, 1973]. One hypothesis regarding the number of acres in the sale tract is that it captures the relative competition in the market for tracts of different sizes. Smaller tracts are more affordable and thus likely to draw more bids. The increased competition may have a positive impact on price. Underlying this market phenomenon is the fact that the purchase of larger acreages entails larger total down payments and larger future cash outflows. They involve larger credit requirements and greater risk of bankruptcy. Thus, only the wealthier buyers are able to contemplate the purchase of large tracts, which reduces the competition for the land.

VanHove [1978, p. 75] further suggests that farm land, in general, may have been overpriced during the period of his sample, the years 1974 through 1976, and while buyers may not have been too sensitive to
this in bidding on small tracts, they may have been much more aware of it when bidding on larger acreages. The hypothesis regarding acres in the sale tract then is that the greater the number of acres, *ceteris paribus*, the smaller the per acre price.

**Finance terms**

Finance terms normally include provisions for the percentage of the purchase price that will be financed (the inverse of the down-payment percentage), the term of the loan, and the interest rate to be paid on the loan. The major interest of this research is on the impact of the down-payment percentage on the price paid for farm land. However, the sample data include cash sales, seller-financed contract sales, and mortgage-financed sales, so it is important to account for any differences among the methods of financing the sale that may have an impact on the selling price.

Reinsel [1973] concluded that seller financing could have an impact on land price. Capital gains income from contract-financed sales can normally be distributed over the life of the contract, whereas capital gains arising from mortgage-financed sales are usually taxable in the year of the sale. In the past though, the down payment on land contracts could not exceed 30 percent of the purchase price. This tax treatment of capital gains gives contract sellers the incentive to adjust their terms relative to the mortgage seller by raising the price and lowering the interest rate. The increments to price are distributed over the life of the contract and taxed at the lower capital gains rate while the interest income is taxed at normal rates.
Thus, in the past, contract sales have usually involved not only a smaller down payment than mortgage-financed sales, but a smaller interest rate and a higher purchase price as well. It was deemed necessary to account for this difference through a variable in the multiple regression equation. The variable chosen for this purpose was the net value of the contract. This value is calculated by first determining the equivalent mortgage value of the contract and then subtracting that equivalent value from the contract price (price per acre times acres sold minus down payment). The equivalent mortgage value for the contract is calculated by discounting the contract payment stream by the appropriate Federal Land Bank mortgage interest rate. The contract payment stream, as indicated below, is the sum of the principal and interest payments and the balloon payment, if any.

\[
\text{Equivalent Mortgage Value} = (\text{Principal} + \text{Interest}) \times \text{PVIFA}_{r,n} + \text{Balloon} \times \text{PVIF}_{r,n}
\]  

(5.4)

where

\[
\text{PVIFA}_{r,n} = \text{the present value interest factor for an annuity at the appropriate Federal Land Bank mortgage rate, } r, \text{ for the number of years of the loan, } n, \text{ and;}
\]

\[
\text{PVIF}_{r,n} = \text{the present value interest factor for a single payment at the appropriate Federal Land Bank rate, } r, \text{ for the year, } n, \text{ in which the balloon falls due.}
\]

The equivalent mortgage value was calculated for all contract sales. In virtually every case, because the Federal Land Bank interest rate was
higher than the contract interest rate, the equivalent mortgage value was less than the contract price. This result is consistent with the hypothesis of Reinsel [1973, p. 34] that seller financing induces a higher selling price for farm land.

The inclusion of the net value of the contract for all observations (cash and mortgage-financed sales were assigned a value of zero) in the multiple regression equation accounts for the special characteristics of contract financing that lead to a higher land price for contract-financed sales. The hypothesized sign of the variable is positive, the greater the contract price relative to the equivalent mortgage value, the higher the price per acre.

The second variable entered in the multiple regression equation to account for the impact of varying financing terms was the down-payment percentage. This variable is very important to the major hypothesis of this research. The down-payment percentage is one minus the purchase leverage of the land buyer. Given the assumptions of the theoretical model, first, that money capital is scarce and second, that the decision maker is under no internal constraint on the use of debt and the assumptions about the market for farm land, one, that land is a purchase of great economic importance to buyers, and two, that the selling price is the result of competitive bidding, then the down-payment percentage should have a negative impact on the selling price. That is, the higher the down payment required on a given sale, ceteris paribus, the lower the per-acre sale price.
A very important assumption about the down-payment percentage is that its determinants are exogenous to the model. This assumption is deemed plausible for the following reasons. First, for contract sales, the size of the down payment is often dictated by local custom and seller tax considerations. Second, for Federal Land Bank mortgages, the down-payment percentage is dictated by the availability of funds to the system. Local availability during most of the 1970s may have been virtually infinite. Furthermore, there is no evidence from the present data that the required down payment is systematically related to the buyer's financial condition. It may be that the buyer's financial condition is crucial in determining whether he is successful in obtaining an FLB mortgage, but among those who are successful and thus included in the data set, mortgage terms are subject to other determinants.

The other financing terms, the term of the loan and the interest rate, while important in general, were not important to this study given the sample and the model specification. There was not enough cross-sectional variation in the term of loan to contribute to an explanation of the cross-sectional variation in land price. Interest rate differences between contracts and mortgages were already considered by the net value of the contract while variations within the mortgage-financed and contract-financed groups were likewise not great enough to account for any of the variability in the price of land.

Missing Observations

Many of the 182 observations in the sample were incomplete. It was deemed appropriate and desirable, however, to salvage as many
observations as possible since those that were incomplete with regard to some items still contained other valuable information. By and large, the limit on the number of usable observations was given by the number that contained a response on the acres owned variable. This variable is crucial to the calculation of the value of acres owned which serves as a proxy in this model for the net worth of the buyer. There were, as stated earlier, 113 observations which included a response to acres owned.

There were 11 observations that did not have an acres owned response but did indicate a net worth category. For these 11 observations, the estimated value of acres owned was found by first, regressing the value of acres owned on the mid-point of the net worth category for the 69 observations in which these two variables existed. The estimated coefficient for net worth category that resulted was then multiplied by the value of the mid-points of the net worth categories of the 11 observations. All of the dollar amounts were deflated, of course, to reflect the 1972 price level. These observations may have included some in which acres owned are actually zero. The value of acres owned for such observations would likewise be zero, but since the value of acres owned is itself only a proxy for net worth, the value of acres owned will be considered to be that which results from the multiplication of the mid-point of the net worth category and the regression coefficient.

This estimating procedure yielded 11 more observations which brought the total to 124. Of these, however, some were missing information on variables other than acres owned. Eighteen of the observations had a
missing value for down payment. The dollar down payment amount is used to calculate the down-payment percentage variable. The value of these missing observations was estimated by substituting, in each case, the average down-payment percentage for the year in which the observation fell and type of financing, contract or mortgage, that financed the sale.

Twelve of the otherwise usable observations were missing a value for total corn yield. The estimating procedure for this variable was to substitute the county average corn yield per acre in the year prior to the year of sale for the county in which the tract lay. These observations, when added to the model, contributed nothing to the significance of the coefficients while lowering the $R^2$ of the regression equation by nearly 18 percent. This group of observations included one tract with a very low selling price ($281 per acre) and several with very high selling prices (over $2500 per acre). It was decided to drop all 12 from consideration since they increased the error sum of squares of the model so drastically.

The remaining 112 observations spanned the years of the sample period, 1969 to 1979. Since the number of observations in each of the years 1969 through 1974 was so sparse, all observations falling in those years were dropped from the final sample. There were 18 such observations, so their exclusion reduced the final sample size to 96 observations.

**Estimation of the Regression Parameters**

Two models were fit using the variables described in the preceding pages. The first of these models, identified as model 1, is defined as
follows:

\[ DPRACRE = F (GRSRET, REALCAPG, GRSWRTHA, ACRES, \\
CNTRCTVA, PERCDWN) \]

where

\[ DPRACRE \] is the per acre sale price of farm land, deflated by the implicit GNP price deflator, 1972 = 100;

\[ GRSRET \] is return to corn production, defined as the product of the expected price of corn, deflated, and the yield in bushels per acre;

\[ REALCAPG \] is the expected real capital gains to holding farm land;

\[ GRSWRTHA \] is the deflated dollar value of acres owned by the land buyer at the time he made the purchase, divided by the number of acres in the tract being purchased;

\[ ACRES \] is the number of acres in the subject tract;

\[ CNTRCTVA \] is the deflated dollar value of the land contract, divided by the number of acres in the sale tract;

and

\[ PERCDWN \] is the down-payment percentage on the land sale.

The second model, model 2, is identical in every way but one; the gross return variable, \( GRSRET \), is separated into its two components, \( CORNPRI \), the expected price of corn and \( TOTYIELD \), the expected corn yield on the acres in the sale tract. In model 2, coefficients were estimated for each of these variables.
The parameter estimates for models 1 and 2 are presented in Table 5.3 below.

**Heteroskedasticity**

Before discussing the results of the estimation, a question arises regarding the regression model and the estimated coefficients. The ordinary least squares procedure used in the estimation assumes that the residuals produced by the estimation have a common variance. If this condition, referred to as homoskedasticity, is violated, then the estimated coefficients, while still unbiased, are inefficient and their estimated variances are biased. The consequences are that the confidence limits and tests of significance developed for ordinary least squares estimators are no longer valid. When the disturbances are not homoskedastic, the confidence intervals and acceptance regions constructed under ordinary least squares assumptions will be wider or narrower than they should be [Maddala, 1977, p. 259].

In the present model, the presence of heteroskedasticity seems most plausible with respect to the proxy variable for net worth (the value of acres owned). In a manner analogous to consumption expenditures across income groups, the land buyer with the greater wealth may have more discretion in the price he can bid on farm land. This may create unequal variances across the wealth groups with the wealthier groups exhibiting the larger variances.

The Goldfeld-Quandt procedure was used to test for the existence of heteroskedasticity with respect to wealth levels [Goldfeld and Quandt, 1965]. This procedure requires that the data set be divided into
Table 5.3. Estimated coefficients for models 1 and 2 using ordinary least squares, t-ratios in parentheses

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERCEPT</td>
<td>234.36&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-312.82</td>
</tr>
<tr>
<td></td>
<td>(1.54)</td>
<td>(-0.69)</td>
</tr>
<tr>
<td>GRSRET</td>
<td>6.66&lt;sup&gt;b&lt;/sup&gt;</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>(8.01)</td>
<td></td>
</tr>
<tr>
<td>CORNPR</td>
<td>---</td>
<td>152.78</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.62)</td>
</tr>
<tr>
<td>TOTYIELD</td>
<td>---</td>
<td>12.69&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(8.25)</td>
</tr>
<tr>
<td>REALCAPG</td>
<td>-2.44</td>
<td>8.55</td>
</tr>
<tr>
<td></td>
<td>(-0.45)</td>
<td>(1.23)</td>
</tr>
<tr>
<td>GRSWRTHA</td>
<td>0.008&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.007&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>(3.13)</td>
<td>(2.54)</td>
</tr>
<tr>
<td>ACRES</td>
<td>-0.96&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-1.01&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>(-2.52)</td>
<td>(-2.54)</td>
</tr>
<tr>
<td>CNTRCTVA</td>
<td>0.70</td>
<td>0.83</td>
</tr>
<tr>
<td></td>
<td>(1.04)</td>
<td>(1.27)</td>
</tr>
<tr>
<td>PERCDWN</td>
<td>-360.24&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-307.84&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>(-3.56)</td>
<td>(-3.09)</td>
</tr>
<tr>
<td>n</td>
<td>96</td>
<td>96</td>
</tr>
<tr>
<td>F</td>
<td>17.53</td>
<td>17.40</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.54</td>
<td>0.58</td>
</tr>
</tbody>
</table>

<sup>a</sup> Indicates significance at the 10% level.

<sup>b</sup> Indicates significance at the 1% level.
subsets across the values of the independent variable of interest. Separate regressions are then run for subsets at the low and high ranges, respectively, of the independent variable. The error sums of squares produced by these regressions can then be used to test the null hypothesis that they are not significantly different.

Two subsets of 24 observations each were taken from the present data set, the first reflecting low wealth ($250 to $1500 of wealth per acre purchased) and the second, high wealth ($5000 and more of wealth per acre purchased). Since, a priori, the second group was expected to have the greater variance, the error sum of squares of the wealthier buyers served as the numerator in the F statistic and the error sum of squares of the less wealthy group as the denominator. The calculated value was 1.06. This compares to a critical F value, with the appropriate degrees of freedom, of 2.33 at the 5 percent level of significance. Thus, the hypothesis of homoskedasticity cannot be rejected at the 5 percent level of significance.

There are several reasons why heteroskedasticity may not be present with respect to the wealth variable. First, the buyer wealth is deflated by the size of the tract being purchased so that the wealth variable is actually in relative and not absolute terms. Second, the wealth variable reflects, in the majority of cases, only the buyer's real estate wealth and not his total wealth. For these reasons, the buyers who occupy the lower and higher ranges of the wealth variable, respectively, may not necessarily be the least and most wealthy in absolute terms.
Discussion of parameter estimates

The coefficients of all variables except one, real capital gains, are of the hypothesized sign. Furthermore, all variables but the real capital gains and the value of the land contract are significant at normally accepted levels.

The sign and magnitude of the variable GRSRET suggest that for every one unit change in expected gross returns, the price of farm land increases by 6.66 units. Thus, a $1 increase in expected gross returns would lead to a $6.66 increase in the price of farm land. These dollar amounts, as noted previously, refer to real dollars.

The variable REALCAPG is of neither the correct sign nor significant. Expected capital gains was anticipated to have a very important positive impact on the price of farm land, especially over the period of the sample. The reason for the unexpected results may lie in the potential multicollinearity between the variable GRSRET, which is a function of the expected price of corn and REALCAPG, which reflects the expected average annual percentage change in the value of farm land in Iowa. As shown in Table 5.4, the largest increases in land values in Iowa coincided with the most substantial increases in the price of corn. Corn prices fell absolutely in 1975, 1976 and 1977 while farm land prices continued to rise, though at a lesser rate of gain. However, as suggested by the specification of the gross returns (GRSRET) and real capital gains (REALCAPG) variables, the demand for farm land is subject to expectations regarding future returns. If these expectations are some function of past price behavior, then the divergence between the two
Table 5.4. A comparison of corn prices and farm real estate prices in Iowa, statewide average, 1969-1979

<table>
<thead>
<tr>
<th>Year</th>
<th>Corn</th>
<th>Farm land</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$/bu.</td>
<td>$/acre</td>
</tr>
<tr>
<td></td>
<td>% change from year earlier</td>
<td>year earlier</td>
</tr>
<tr>
<td>1969</td>
<td>1.09</td>
<td>419</td>
</tr>
<tr>
<td>1970</td>
<td>1.17</td>
<td>419</td>
</tr>
<tr>
<td>1971</td>
<td>1.04</td>
<td>430</td>
</tr>
<tr>
<td>1972</td>
<td>1.11</td>
<td>482</td>
</tr>
<tr>
<td>1973</td>
<td>1.81</td>
<td>635</td>
</tr>
<tr>
<td>1974</td>
<td>2.87</td>
<td>834</td>
</tr>
<tr>
<td>1975</td>
<td>2.66</td>
<td>1,095</td>
</tr>
<tr>
<td>1976</td>
<td>2.45</td>
<td>1,368</td>
</tr>
<tr>
<td>1977</td>
<td>1.98</td>
<td>1,450</td>
</tr>
<tr>
<td>1978</td>
<td>2.04</td>
<td>1,646</td>
</tr>
<tr>
<td>1979</td>
<td>2.25</td>
<td>1,958</td>
</tr>
</tbody>
</table>
price series in 1975, 1976 and 1977 is not necessarily inconsistent. Additionally, of course, the price of corn is only one of the prices relevant to evaluating the return to farm land in Iowa. Thus, since the real capital gain variable was constructed from the Iowa farm land price series and since the price series is, to a degree, correlated with the corn price series, there is a potential for multicolinearity in a model that includes both the corn price and real capital gains. Another regression model, referred to as model 2a, which excluded the price of corn and included total yield and real capital gains was fit. In that model, as shown in Table 5.5, the coefficient for REALCAPG was both positive and significant.

Model 2, shown in Table 5.4, estimates a separate coefficient for the price of corn (CORNPR) and total corn yield (TOTYIELD). The coefficient of CORNPR, while of the correct sign, is not significant. TOTYIELD, also of the correct sign, is significant at the one percent level. The coefficient for total yield suggests that a one unit increase in the corn yield per acre will raise the per acre land price by 12.5 units. These units, as defined in the model, are bushels per acre and dollars per acre, respectively.

In model 2, the variable REALCAPG has an estimated coefficient of 8.5, which is of the correct sign, and a standard error of 7.0. This produces a t-ratio which, while not significant at normally reported levels, is significant at the 15 percent level. The interpretation of this coefficient is that a one unit increase in real capital gains, which amounts to a one percentage point, raises the price of farm land by
Table 5.5. Estimated coefficients for model 2a (the variable CORNPR excluded) using ordinary least squares, t-ratios in parentheses

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 2a</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERCEPT</td>
<td>-39.76</td>
</tr>
<tr>
<td></td>
<td>(-0.24)</td>
</tr>
<tr>
<td>TOTYIELD</td>
<td>11.14&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>(8.02)</td>
</tr>
<tr>
<td>REALCAPG</td>
<td>16.87&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>(4.30)</td>
</tr>
<tr>
<td>GRSWRTHA</td>
<td>0.007&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>(2.55)</td>
</tr>
<tr>
<td>ACRES</td>
<td>-1.15&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>(3.18)</td>
</tr>
<tr>
<td>CNTRCTVA</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>(1.25)</td>
</tr>
<tr>
<td>PERCDWN</td>
<td>-264.24&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>(-2.72)</td>
</tr>
</tbody>
</table>

n = 96
F = 19.98
R<sup>2</sup> = 0.55

<sup>a</sup>Indicates significance at the 1% level.
$8.50 per acre.

For the remaining variables in models 1, 2, and 2a, there was virtually no difference in the coefficients and their levels of significance. The coefficients estimated in model 2 will be discussed because of their slightly smaller standard errors.

Referring again to Table 5.3, the coefficient for the variable GRSWRTHA is seen to be positive, as hypothesized, and significant at the one percent level. The variable GRSWRTHA is a measure of the value of the farm real estate owned by the buyer at the time he made the subject purchase, divided by the number of acres in the purchased tract. While the sign of GRSWRTHA is correct, the magnitude of the coefficient is quite small. A $1 increase in the value of acres owned per acre to be purchased would increase the price paid for those additional acres by $.007 per acre. However, there is no reason to expect a very large impact. Most studies on the determinants of farm land prices indicate that the characteristics of the sale tract itself and conditions in the markets for agricultural output are the most important determinants of price [Reynolds and Timmons, 1969; Klinefelter, 1973; Herr, 1975; Chavas and Shumway, 1982; Sandrey et al., 1982]. The present study confirms these findings but suggests, as well, that some other factors are of importance.

In interpreting the coefficient of GRSWRTHA it must be kept in mind that, given the variable's specification, it does not address the issue of how absolute wealth may affect the price paid for farm land. Instead, it suggests how wealth, relative to the size of the purchase, may affect
the price paid. As mentioned in the discussion on heteroskedasticity, a buyer's position *vis-a-vis* others on the GRSWTHA scale will not necessarily match his position on a scale denoting absolute wealth. But, in the market for farm land, the impact of wealth on any given transaction would depend on how that wealth could be brought to bear on that particular purchase. To the extent that the coefficient of GRSWTHA is positive, it suggests that relative wealth does have a role, *ceteris paribus*, in determining the price bid for farm land.

ACRES, the variable representing the number of acres in the sale tract, had an estimated coefficient of -1.0 which means that a one acre increase in the size of the sale tract lowers the sale price, in real terms, by $1.00. The reasons for this, as discussed earlier, involve competition in the market for farm land. The smaller tracts are likely to draw more bidders and perhaps more vigorous bidding from expansion buyers than larger tracts.

The variable which denotes the net value of the land contract, CNTRCTVA, is of the correct sign, positive, but like REALCAPG is significantly different than zero only at the 15 percent level. This coefficient, whose estimated value is 0.83, should be close to one. It measures the value of a land contract compared to a mortgage of equivalent principal and interest payments and equivalent terms made at the same time and the net contract value should, for the most part, translate into a higher land price on a dollar for dollar basis.

The final variable in the regression equation, PERCDWN, is both negative, as hypothesized, and significant at the one percent level. No
The hypothesis was formulated about the expected magnitude of the coefficient. The coefficient measures the intensity of the money capital constraint facing the land buyer. Thus, a larger absolute value would indicate a more severe money capital constraint and a smaller absolute value, a less severe money capital constraint. The value of the coefficient estimated in model 2 was -307.84 which can be interpreted to mean that a one unit decrease in the down-payment percentage, a change in the required percentage of one percent, raises the price of farm land by $3.07 per acre.

The Interaction Between Down-Payment Percentage and Wealth

The theoretical model described in Chapter III suggests that the magnitude of the coefficient of the variable PERCDWN could be influenced by the amount of equity available to the buyer. In its most general application, the model of decision maker behavior expressed in Equation (3.41) could be solved for the demand for debt as well as the demand for factor inputs. The demand for debt would be some function of the availability of equity assuming that the decision maker's capitalization rate varied with his leverage ratio.

But, even without endogenously determined debt; with instead, the assumption that the buyer is taking all the debt that is offered to him, the value of his initial equity may still have an impact on the way the down-payment percentage affects the price he bids for farm land. This occurs simply because the impact of the down-payment percentage (the coefficient of PERCDWN in the regression equation) measures the severity of the money capital constraint and the severity of the money capital
constraint is also a function of the availability of money capital in the form of existing equity. Using the variable GRSWRTHA as a proxy for the existing level of equity, the hypothesized interaction between down-payment percentage and buyer wealth can be introduced into the regression equation by adding an interaction term [Kmenta, 1971, pp. 455-457]. This term, with the variable name INTERACT, is the product of the variables PERCDWN and GRSWRTHA.

The hypothesis about the sign of this variable may best be approached from the analysis of Turnovsky [1970] regarding the relationship between debt and equity. His analysis suggests that debt and equity are likely to be complementary methods of finance when the level of existing equity is small and likely to be substitute methods when the existing level of equity is high [Turnovsky, 1970, p. 1078]. In the present case, one could hypothesize, given the traditional debt accumulation patterns of farmers, that younger farmers who are generally less wealthy, hoping to build up the value of their assets on a given equity base, would regard debt and equity as complements, while established farmers, more likely to have achieved an optimal scale of production, would regard the two as substitutes. This "life cycle" view of farming suggests a period of debt accumulation followed by a period of debt retirement. To say that debt and equity are regarded as complements is to say that an increase in the equity available to the firm would increase the amount of debt used. The firm's leverage ratio, in other words, would remain constant or increase as its equity base rose. To say that debt and equity are substitutes, on the other hand,
is to say that an increase in equity will result in a concomitant
decrease in debt use.

Those land buyers with smaller equity could thus be expected to be
more sensitive to changes in the down-payment percentage. That is,
their demand for land and the price they would be willing to pay,
ceteris paribus, would be more responsive to changes in the down-payment
requirement.

Conceptually, therefore, the sign of the variable INTERACT is
ambiguous. Looking at the complete regression model with the interaction
term,

\[ DPRACRE = \alpha + \beta_1 (GRSRET) + \beta_2 (REALCAPG) + \beta_3 (GRSWRTHA) + \beta_4 (ACRES) + \beta_5 (CNTRCTVA) + \beta_6 (PERCDWN) + \beta_7 (INTERACT) \]  

where

\[ INTERACT = PERCDWN \times GRSWRTHA . \]

The impact of the variable PERCDWN on the dependent variable DPRACRE
in this model is given by the expression:

\[
\frac{\partial DPRACRE}{\partial PERCDWN} = \beta_6 + \beta_7 (GRSWRTHA) .
\]  

This expression states that the impact of the down-payment percentage
changes with the level of wealth. If the coefficient \( \beta_6 \) is negative as
suggested by the previous analysis, and debt and equity are regarded as
substitute methods of finance, then \( \beta_7 \) would have to be positive to reflect the modifying influence of the equity level on the impact of the down-payment percentage on price paid. If this were true, an increase in the required down-payment percentage, while still having a negative impact, would have a less negative impact as the equity level rose. If debt and equity relate as complements, the sign of the coefficient, \( \beta_7 \) should be negative. An increase in the down-payment requirement while, again, having a negative impact, would have a more negative impact as equity level rose. If, on the other hand, the down-payment requirement fell, the positive impact on price would be even more positive at high equity levels.

The data used in this study do not, of course, describe the behavior of an individual buyer over varying levels of equity, but instead describe the behavior of the land market when buyers with varying levels of wealth bid for farm land. To say that buyers at the low and high ends of the GRSWRTA variable regard debt and equity as complements and substitutes in financing, respectively, disregards the fact that the level of equity is really a relative concept and that two buyers with the same level of equity may regard the absolute size of that level in entirely different ways. But, even if the statement is made that those lower on the scale of the variable GRSWRTA regard debt and equity as complements and those higher on the scale regard them as substitutes, the sign of INTERACT may still be ambiguous since it would depend on which group dominated.
On the other hand, several factors would seem to favor the hypothesis that debt and equity be viewed as complementary forms of finance, at least among farm land buyers. For one thing, the rate of growth in nominal land prices in Iowa, which averaged almost 20 percent in the latter half of the 1970s, encouraged the use of borrowed funds to purchase land. For another, Federal Land Bank funds were generally available during this period at very competitive rates of interest. Finally, the population of farm land buyers is likely to include a large proportion of farmers in early to mid-career (in the present sample, the average number of years in farming is 18) who would tend to be in the acquisition stage of their life cycles.

Both model 1 and model 2 were reestimated with the addition of the interaction term. The results, with the models labelled 4 and 5, are presented in Table 5.6 below.

The addition of the interaction term does not materially alter the value or statistical significance of most of the variables in the models. The variable whose coefficient is most affected is GRSWRTHA. The value of the coefficient is increased and the statistical significance is reduced to the five percent level in the case of model 4 and the ten percent level in the case of model 5.

The sign of the coefficient of the variable INTERACT is negative in both cases but the t-ratios are rather low, -1.36 and -0.80 for model 4 and model 5, respectively. These suggest that for model 4 at least, the coefficient is significantly different from zero at the ten percent level. The implication of the negative sign of the coefficient is, as
Table 5.6. Estimated coefficients for models 4 and 5 (with interaction term) using ordinary least squares, t-ratios in parentheses

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 4</th>
<th>Model 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERCEPT</td>
<td>181.61</td>
<td>-373.72</td>
</tr>
<tr>
<td></td>
<td>(1.16)</td>
<td>(-0.82)</td>
</tr>
<tr>
<td>GRSRET</td>
<td>6.46&lt;sup&gt;a&lt;/sup&gt;</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>(7.67)</td>
<td></td>
</tr>
<tr>
<td>CORKNPR</td>
<td>---</td>
<td>177.48</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.71)</td>
</tr>
<tr>
<td>TOTYIELD</td>
<td>---</td>
<td>12.46&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(7.95)</td>
</tr>
<tr>
<td>REALCPG</td>
<td>-1.71</td>
<td>8.25</td>
</tr>
<tr>
<td></td>
<td>(-0.31)</td>
<td>(1.18)</td>
</tr>
<tr>
<td>GRSWRTHA</td>
<td>0.02&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.01&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>(2.09)</td>
<td>(1.39)</td>
</tr>
<tr>
<td>ACRES</td>
<td>-0.84&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.94&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>(-2.15)</td>
<td>(-2.47)</td>
</tr>
<tr>
<td>CNTRCTIVA</td>
<td>0.60</td>
<td>0.76</td>
</tr>
<tr>
<td></td>
<td>(0.90)</td>
<td>(1.16)</td>
</tr>
<tr>
<td>PERCDWN</td>
<td>-282.47&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-266.13&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>(-2.44)</td>
<td>(-2.36)</td>
</tr>
<tr>
<td>INTERACT</td>
<td>-0.02&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-0.01</td>
</tr>
<tr>
<td></td>
<td>(-1.36)</td>
<td>(-0.80)</td>
</tr>
<tr>
<td>n</td>
<td>96</td>
<td>96</td>
</tr>
<tr>
<td>F</td>
<td>15.44</td>
<td>15.24</td>
</tr>
<tr>
<td>R&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0.55</td>
<td>0.58</td>
</tr>
</tbody>
</table>

<sup>a</sup>Indicates significance at the 1% level.

<sup>b</sup>Indicates significance at the 5% level.

<sup>c</sup>Indicates significance at the 10% level.
discussed earlier, that the impact of the down-payment percentage on the price paid for farm land, which is negative, is more negative at higher levels of GRSWRTHA. This further implies that a decrease (increase) in the required down-payment percentage will then have a greater positive (negative) impact on the price paid for farm land the higher the level of equity as measured by GRSWRTHA.

Elasticities

To further aid in the interpretation of the regression coefficients, the elasticities of the coefficients estimated in models 1 and 2 were calculated and are presented in Table 5.7.

The elasticities were calculated at the mean values of the independent variables and represent a measure of the responsiveness of the dependent variable, DPRACKE, to changes in the values of the independent variables. As a ratio of the percentage change in one variable to the percentage change in another variable, the elasticity coefficient is unit-free.

The elasticity coefficients calculated for model 1 show that changes in the per acre price of farm land are largest with respect to changes in the level of gross returns. The elasticity coefficient for GRSRET is 1.02 meaning that a one percent change in gross returns leads to a 1.02 percent change in the price of farm land. At the sample means of the variables GRSRET and DPRACRE, a one percent increase in GRSRET, $1.88, would result in an increase of $12.54 per acre in the price of farm land.

The variable with the next largest elasticity is PERCDWN. Its coefficient can be interpreted to mean that a one percent change in the
Table 5.7. Elasticity coefficients for the parameter estimates of models 1 and 2

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1</th>
<th></th>
<th>Model 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\hat{\beta}_j$</td>
<td>$E_j$</td>
<td>$\hat{\beta}_j$</td>
<td>$E_j$</td>
</tr>
<tr>
<td>GRSRET</td>
<td>6.66$^a$</td>
<td>1.02</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>CORNPR</td>
<td>---</td>
<td>---</td>
<td>152.78</td>
<td>0.23</td>
</tr>
<tr>
<td>TOTYIELD</td>
<td>---</td>
<td>---</td>
<td>12.69$^a$</td>
<td>1.05</td>
</tr>
<tr>
<td>REALCAPG</td>
<td>-2.44</td>
<td>-0.04</td>
<td>8.55</td>
<td>0.13</td>
</tr>
<tr>
<td>GRSWRTHA</td>
<td>0.008$^a$</td>
<td>0.03</td>
<td>0.007$^a$</td>
<td>0.03</td>
</tr>
<tr>
<td>ACRES</td>
<td>-0.96$^a$</td>
<td>-0.10</td>
<td>-1.01$^a$</td>
<td>-0.11</td>
</tr>
<tr>
<td>CNTRCTVA</td>
<td>0.70</td>
<td>0.01</td>
<td>0.83</td>
<td>0.01</td>
</tr>
<tr>
<td>PERCDWN</td>
<td>-360.24$^a$</td>
<td>-0.11</td>
<td>-307.84$^a$</td>
<td>-0.10</td>
</tr>
</tbody>
</table>

$^a$Indicates significance at the 1% level.
percentage down-payment requirement results in a .11 percent change, in the opposite direction, in the per acre price of farm land. For example, at the mean values of DPRACRE and PERCDWN, $1229 and 39 percent, respectively, a one percent increase from the mean in the down-payment percentage, 0.4 percent, would result in a reduction of the per acre price for farm land of .11 percent or $1.35. Given the average sized sale tract, 129 acres, the total price would fall by $174. In a, perhaps, more meaningful comparison, if the down-payment percentage requirement rose by one percentage point, from 39 percent to 40 percent, the per acre price of farm land would be expected to fall by .28 percent or $3.44. On the basis of 129 acres, the average size sale tract, this decrease amounts to $443.76.

Other elasticity coefficients of interest in model 1 are those of the variables GRWRTHA and ACRES. The coefficient for GRWRTHA, 0.03, implies that a one percent increase in GRWRTHA, $53 at the mean value, would result in an increase of .03 percent or $.37 in the per acre price of farm land. The responsiveness of price to the number of acres in the sale tract is greater, as reflected in the elasticity coefficient of -0.10. A one percent increase in the size of the sale tract, 1.3 acres at the mean value, means an increase of .10 percent or $1.23 in the per acre price of land.

The elasticity coefficients in model 2 for the variables GRWRTHA, ACRES, and PERCDWN are quite similar to those in model 1. An additional elasticity of interest in model 2 is that for total corn yield. The elasticity for TOTYIELD is 1.05 which implies that a one percent increase
in total corn yield would result in a slightly greater than one percent increase, 1.05 percent, in the per acre price of land. At the mean sample value of TOTYIELD, 102 bushels of corn per acre, this means that an increase in yield of 1.02 bushels per acre results in a $12.53 per acre increase in the price of land.
CHAPTER VI. SUMMARY AND CONCLUSIONS

Objectives

The objective of this study is to examine the effect of the interrelationship between farm financial structure, the down-payment requirements for farm land purchase and the price paid for farm land.

Three hypotheses emerged from this examination. The first is that the required down-payment percentage on farm land purchases in part determines money capital availability. And, in turn, this availability affects the demand for and therefore the price of farm land. The second hypothesis is that the amount of equity available to the decision maker at the time he makes the farm land acquisition also influences, in a positive manner, the price he pays. The third hypothesis is a suggestion that there is an interaction between down-payment percentage and equity availability that bears on the impact of the down-payment percentage. These three hypotheses are examined both theoretically and empirically.

Theoretical and Statistical Analyses

This study has employed the neo-classical model of firm behavior in deriving the demand for farm land under the condition of money capital scarcity. The objective function is defined as the discounted return to owner's equity. The demand for fixed inputs (i.e. farm land) is shown to be a function of the price of the firm's output, the price of all inputs, and the availability of money capital from both debt and equity sources. With the assumption that the level of equity is fixed,
the availability of money capital depends on the availability of debt which is reflected in the down-payment requirement. When money capital is constraining, the fixed input price at which firm equilibrium is achieved is lower, ceteris paribus, than when money capital is not a constraint. An easing of the constraint through more liberal down-payment terms will, ceteris paribus, raise the equilibrium level of employment of the fixed input. Differences in the initial level of equity will likewise have an impact, through the shadow price of the money capital constraint, on the input price level at which equilibrium between the value of the marginal product and the marginal factor cost is achieved. Because the down-payment requirement and the initial equity level both bear on the availability of money capital, an interaction between the two may also exist. Specifically, as the initial equity level varies, the impact of changes in the down-payment requirement may also vary.

Empirical testing of these hypotheses has been accomplished with the use of a single equation econometric model. In a cross-sectional analysis of farm land sales in Iowa, the dependent variable, per-acre price paid for farm land, is hypothesized to be a function of gross return, represented by the price of corn and the corn yield of the land, real capital gains to farm land, the gross value of farm land already owned by the buyer at the time of the purchase, the acres in the sale tract, the differential in sale price due to contract financing and the down-payment percentage on the purchase. The down-payment percentage and gross value of buyer's real estate variables tested the hypotheses
regarding the impact of money capital scarcity while the other variables were included to set the \textit{ceteris paribus} conditions. The model was reestimated with the addition of an interaction term to test the third major hypothesis.

The results of the statistical analysis showed that the first two hypotheses could not be rejected at normally accepted levels of significance. The down-payment percentage and the equity level of the buyer, as proxied by the value of his farm real estate, did indeed have the anticipated impacts on the price paid for farm land. The third hypothesis, that of an interaction between down-payment percentage and equity level could be accepted, but only with less confidence. The sign of the interaction variable turned out to be negative which implies that a higher (lower) level of wealth relative to the number of acres purchased has a heightening (dampening) effect on the impact of the down-payment percentage on the price of farm land.

Conclusions

The three hypotheses that are directly addressed, though narrow in focus, are much broader in implications. Three areas upon which the results of the statistical analysis may shed some light have been identified. These are, first, the correctness of the assumptions of money capital scarcity and no internal capital rationing upon which the model is conditioned; second, the relationship between the price of farm land and its value as derived from conventional valuation formulas; and third, the impact of existing wealth on bid prices for land and the resulting pattern of farm land ownership.
Turning to the first of these three areas, the model from which all hypotheses have been drawn assumes that money capital is a scarce commodity and that no internal capital rationing takes place. In the absence of money capital scarcity the model developed to trace the impact of down-payment percentage would collapse to the standard neoclassical model of input demand wherein the availability of funds to purchase inputs is not at issue. The fact that the price of farm land has been shown to be influenced by the percentage down-payment requirement implies that availability of funds is indeed an issue in input demand and that a model which allows for money capital scarcity is a more accurate representation of reality.

The assumption of no internal capital rationing is more difficult to justify. While land buyers have been seen to have responded to more credit by bidding land prices upward, they may still have been subject to some internal constraint as to the amount of credit they would use. Thus, they might have been making larger down payments than they would have had to because they felt the risks of taking on additional debt to be too great. The estimation of the model with the interaction term perhaps lends some clarification to this issue. One might expect those with greater equity to be the most likely candidates for internal capital rationing because they are more likely to have achieved the financial structure they desire. If this were the case, the sign of the interaction term would be positive, indicating that the impact of the down-payment percentage on price was less for those with greater equity. The sign of the interaction term is instead negative which
implies that the buyers with the greatest equity were, in fact, most responsive in terms of bidding to changes in the down-payment percentage. While this does not prove the case for no internal capital rationing, it does indicate that the group most likely to be subject to internal rationing is actually more responsive to external capital rationing. The previously discussed warnings apply to this analysis. That is, first, the statistical significance of the interaction variable is weak and second, the equity of buyers is measured by the proxy variable, value of acres already owned.

The second issue on which the results of the statistical analysis may have some bearing is the issue of farm land price versus farm land value and the adjustments between them. This issue is not entirely separate from the issue of the presence or absence of money capital scarcity. By definition, an operative constraint means that the limited resource has a positive marginal value to the function being maximized.

Both market price and valuation price are made under conditions of limited information and misinformation. Furthermore, land valuation as conventionally practiced does not account well for the characteristics of the potential buyer such as his access to credit. A land valuation or net present value formulation can employ a higher discount rate to reflect the scarcity of credit but, realistically, credit is often made more available at no significant increase in cost or is unavailable at any price. The model developed and used in this study more nearly captures that aspect of credit availability. The empirical results of the present study suggest that farm land prices, even though
considered "high", still lagged perceived value, since credit expansion to buyers had a positive impact on market price. In this regard, the results of the study concur with a recent article by Shalit and Schmitz [1982]. These authors contend that increases in the supply of credit to farms with land as collateral will cause farm land prices to rise at a faster rate than with no increase in supply. They go on to say that the expansion and contraction of credit has an important impact on the pace of farm land price increases or decreases [Shalit and Schmitz, 1982, p. 718]. This conclusion makes sense in light of the fact that the farm land market operates under a credit constraint and the more responsive credit supply is (the less sticky the credit constraint) the more quickly land prices will adjust to perceived land value. A question for policy makers that arises from this is to what extent can changes in Federal Land Bank regulations concerning minimum down-payment requirements or changes in tax laws that encourage or discourage the use of land contracts influence the rate of adjustment of farm land prices.

The third area of issues is that of the impact of existing wealth on the price and ownership of farm land. The empirical model proved that the level of existing wealth in terms of the value of owned farm land relative to the size of the purchase had a positive impact on the price of farm land. This clearly suggests that, ceteris paribus, the wealthier buyer enjoys a bidding advantage in the market for farm land, a result consistent with the hypotheses of Lee and Rask [1976] and Harris and Nehring [1976]. Credit made available through lower
down-payment requirements, across-the-board to buyers would presumably heighten that bidding advantage while at the same time raising land prices even further.

Some additional evidence as to the impact of wealth and credit availability comes from the analysis of the interaction model. This model suggests that the wealthier buyers are more responsive to variations in required down-payment percentage which means that, in the case of lower down-payment requirements, wealthier buyers combine both their superior wealth and the more liberal credit terms to bid land prices upward.

The resulting ownership pattern would be more farm land concentrated in fewer hands. This, as well, has implications for policy makers in their attempts to influence such ownership patterns. Credit availability may have to be targeted to specific groups if more widespread ownership of farm land is desired.

Limitations of the Study

Perhaps the most important limitation of the present study is that the model developed to analyze the data is only a special case of a more general specification. To a large extent, the limitations of the available data set demanded this.

The more general specification of the model would solve the Lagrangian function (presented as Equation (3.41) in Chapter III) for the optimal level of debt as well as the optimal levels of factor input use. The demand for debt would be seen to be a function not only of the current interest rate and the current leverage ratio of the firm,
but also of how the addition of debt to the firm's financial structure would influence the interest rate it paid and the discount rate it used in evaluating additional profits. In terms of an econometric model, the demand for debt and the price of farm land would be solved by the use of the two-stage least squares procedure using the estimated demand for debt as an argument in the farm land price equation. Such a model would require a data set that would discriminate among land buyers on the basis of their accumulated debt.

A second limitation has again to do with the specification of the model. Although the land prices the model is attempting to predict arise from decisions made by both buyer and seller, the model specified to predict them is derived from consideration of buyer behavior only. In other words, the model is not a market model even though farm land prices are market determined. Some of the factors that influence the supply of farm land are identical to those that influence demand. The expected price of farm commodities and expected capital gains on farm land would likely be of importance to both supply and demand. But, other factors such as off-farm employment opportunities and age and financial condition of the seller may also have important impacts on the market price of farm land.

A third limitation concerns the derivation of the expected corn price and expected real capital gains variables. The explanatory power of these two may be much greater in a time series model where more variation with respect to expectations may occur. However, even in a strictly cross-sectional study there would likely be sizable variation
in expectations of future prices and capital gains that might be a function of buyer characteristics such as age, education, wealth, experience in farming and experience in buying land. In the present study, expected corn prices and capital gains are generated from a simple averaging of past prices. A more sophisticated or, at least, more discriminatory device for generating expectations would possibly improve the accuracy of the variables.

The final limitation has to do directly with the available data set. In particular, the lack of a more exact measure of buyer equity limits the reliability of the statistical results. The use of a proxy variable introduces measurement errors into the regression equation and the ordinary least squares procedure applied to this equation may produce an inconsistent estimator.

Suggestions for Future Research

Future research in the area of capital availability and land prices might well expand the model and analysis presented in this study to include a consideration of endogenously determined debt. While a complete financial profile of land buyers may be difficult to obtain, it may be possible to construct an adequate data set from what is available.

The implications of the balance sheet and financial structure for asset demand are well-known in financial theory. Their implications within the context of economic theory can be easily ascertained once some of the simplifying assumptions of the neoclassical model of firm behavior are relaxed. Examination of these implications has a long
though sporadic literature. Empirical verification of these implications has virtually no literature and that is the area toward which future research might profitably be directed.
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"Iowa Land Value Survey." Iowa Agricultural Extension Service, various years.


ACKNOWLEDGMENTS

I thank my major professor, Duane Harris, and the remainder of my dissertation committee for their assistance, Phil Eberle for his help, especially in organizing the data set, and my family for their perseverance.
APPENDIX: COMPARABLE SALE WORKSHEET
Comparable Sale Worksheet

Comparable Sale # ____________________ Student Name ____________________

I. TRANSFER INFORMATION (AUDITOR'S OFFICE)
   A. Seller (Grantor): _________  B. Buyer (Grantee): _________
   C. Date of Instrument: _________  D. Number of Acres: _________
   E. County: _________  Township: _________  Nearest Town: _________
   F. Legal Description:

II. SALE PRICE INFORMATION (RECORDER'S OFFICE)
   A. Deed Book (Verify Legal Description)
      1. Consideration Shown: $_________
      2. Date of Deed: _________  3. Stamp Tax: $_________
      4. Other (e.g. assumed mortgage): ____________________________

   B. Mortgage and Contract Book
      1. Type of Financing (Check One): Mortgage ___; Contract ___
      2. Date of Mortgage or Contract: ______________
      3. Downpayment: $_________
      4. Amount of Mortgage or Contract: $_________
      5. Interest Rate: _____% 
      6. Term: _________ years
      7. Payment Pattern
         a. Periodic Payments: $_________
         b. Balloon Payment: $_________
C. Sale Price Verification

1. Verification by: ______________________
   Date: _______________ Place: _______________________

2. Consideration Paid: $_______________

3. Per Acre Value: $_______________

III. ASSESSMENT AND TAX INFORMATION (ASSESSOR'S AND TREASURER'S OFFICE)

A. Date of Assessment: ______________________

B. Assessed Value

   1. Land: $__________
   2. Buildings: $__________
   3. Total: $_______________

C. Tax Levy: $_______________/thousand

D. Total Taxes: $_______________

E. Taxes Per Acre: $_______________

IV. CHARACTERISTICS OF FARM (ASSessor'S OFFICE AND OTHER)

A. Location:

   1. Distance to Nearest Farm Supply and Marketing Center: ___________ miles

   2. Road Surface (Check One): County Gravel _____; County Blacktop _____; State Highway _____; Federal Highway _____

B. Productivity (Under Highest and Best Use):

   1. Number of Tillable Acres: ________________
   2. Number of Acres in Permanent Pasture: ________________
   3. Number of Acres in Waste and Farmstead: ________________
   4. Total Farm Average CSR: ________________
5. Tillable Acres Average CSR: ____________
6. Total Farm Average Corn Yield: ____________
7. Tillable Acres Average Corn Yield: ____________

C. Buildings and Improvements:
1. Buildings Condition (Check One): Obsolete ____; Poor ____
   Average ____; Above Average ____; Excellent ____
2. Specialized Facilities (Check Where Appropriate):
   Confinement Hog Operation ____; Confinement Cattle
   Operation ____; Harvester Silo(s) ____; Other ___________
   ______________________ (Describe)
3. Terraces (Check One): None ____; Some ____;
   Extensive ____
4. Tilling (Check One): None ____; Some ____;
   Extensive ____

V. CHARACTERISTICS OF BUYER

A. Form of Ownership (Check One): Owner-Operator ____; Local
   Landlord ____; Absentee Landlord ____

B. Type of Organization (Check One):
   1. Single Proprietor ____
   2. Partnership ____; Number of Owner-Operators ____
   3. Family Corporation ____; Number of Owner-Operators ____
   4. Other Corporation ____

C. Size of Operation Before Acquisition (If Owner-Operator):
   1. Number of Acres Owned: __________
   2. Number of Acres Rented-In: __________
3. Number of Tractors (over 20 hp) Owned: __________
   a. Horsepower: ____; ____; ____; ____; ____; ____
   b. Age: ____; ____; ____; ____; ____; ____

4. Number of Self-Propelled Combines: __________
   a. Number of Rows on Corn Head: ____; ____; ____; ____
   b. Age: ____; ____; ____; ____; ____

D. Location of Buyer (If Owner-Operator):
   1. Distance from Farm Base to New Acquisition: ________miles

E. Personal Characteristics of Buyer at Time of Acquisition (If Owner-Operated):
   1. Number Years Farming of Owner-Operator(s): ____ ____ ____
   2. Highest Year of School Completed of Owner-Operator(s):
      ____ ____ ____
   3. Number of Anticipated Owner-Operators to Join Farming Unit During Next Five Years: ________

4. Amount of Off-Farm Income of Owner-Operator(s) and Family(ies) (Check One): None ____; $1-5,000 ____; $5,001-$10,000 ____; $10,001-$15,000 ____;
   $15,000 and above ____

5. Amount of Net Worth of Owner-Operator(s) and Family(ies) (Check One): $0-$50,000 ____; $50,001-$100,000 ____; $100,001-$150,000 ____; $150,001-$200,000 ____;
   $200,001 and above ____

VI. COMMENTS: