73-25,255

STOUT, Roscoe Eugene, 1944-
LAND AS A COMPETITIVE ASSET AND CAPITAL PROXY.

Iowa State University, Ph.D., 1973
Economics, general

Land as a competitive asset and capital proxy

by

Roscoe Eugene Stout

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

1973

TABLE OF CONTENTS

CHAPTER I. INTRODUCTION AND HISTORICAL BACKGROUND

Introduction

While the research reported in this paper does provide a method for predicting United States farm real estate price variation, its primary purpose is to examine a more significant problem--the substitutability between real and monetary assets in portfolio adjustments and the implications of such substitution toward the potential strength of monetary policy in affecting aggregate income.

Historical Background

The classical system with its full-employment equilibrium under flexible prices really left no room for monetary policy in affecting aggregate income. Keynes' General Theory (1936) attacked the full-employment nature of the classical system, but more importantly, he attacked the classical separation of monetary and value theory. This separation, causing relative prices to be determined by real supply and demand forces and the price level to be determined by the quantity of money and its velocity, became known as the "classical dichotomy" after Patinkin (1949), who later (1954) included real balances in the demand for money to "validate" the dichotomy.

The Keynesian system treated money as simply another asset after Hicks' "suggestion" (1935) for a marginalist approach to monetary theory. Pigou had already described the utility of money for such an approach when he imputed to money a rate of return varying inversely to money holdings relative to transactions needs and the wealth of the holder, but the Cambridge theorists seemingly ignored his ideas in setting their demand for money as a constant proportion of income, leading, of course, to the criticism of "a variable unprotected by functional notation" (Friedman, 1956). After the Keynesian revolution and the ensuing debate on the internal consistency (valid versus invalid dichotomy) of the classical model, Pigou (1943) again called for a recognition of the role of wealth in the demand for money claiming that such recognition would restore the consistency of the classical model. Thus, the "Pigou effect" linked the theory of value into monetary theory.

The Keynesian System

The critical assumptions of the Keynesian system from a monetary standpoint are the low interest elasticity of investment and the high interest elasticity of the demand for money (at least at low rates). The ultimate policy conclusions of the Keynesian model can be shown to rest on these critical assumptions by examining the following simple, linearized Keynesian model:

let

Y = aggregate income

C = consumption

I = investment

S = saving

T = taxes

G = government expenditures, exogenously determined

r = the rate of interest

M^d = the demand for money

M^s = the supply of money, exogenously determined

$\alpha_o, \alpha_1, \gamma_o, \gamma_1, \lambda_o, \lambda_1, \beta_o, \beta_1$ = positive constants,

then,

$$Y = C+I+G \tag{1.1}$$

$$Y = C+S+T \tag{1.2}$$

$$S = -\alpha_o+\alpha_1(Y-T) \tag{1.3}$$

$$T = \gamma_o+\gamma_1(Y) \tag{1.4}$$

$$I = \lambda_o-\lambda_1(r) \tag{1.5}$$

$$M^d = \beta_o(Y)-\beta_1(r) \tag{1.6}$$

$$M^d = M^s \quad . \tag{1.7}$$

While simple, this model nonetheless retains the essential characteristics of the Keynesian system: saving is a function of disposable income, the rate of interest is determined by the supply and demand for money, there is a transactions demand $[\beta_o(Y)]$ and a speculative demand $[-\beta_1(r)]$ for money.

One can solve Equations 1.6 and 1.7 for the rate of interest and then solve the system for aggregate income. The reduced form of the model in Y is:

$$Y = \frac{\beta_1(\alpha_o - \gamma_o + \alpha_1\gamma_o + \lambda_o)}{\Theta} + \frac{\lambda_1 M^S}{\Theta} + \frac{\beta_1 G}{\Theta} \tag{1.8}$$

where $\Theta = \lambda_1\beta_o + \beta_1(\alpha_1 - \alpha_1\gamma_1 + \gamma_1)$. Clearly, as β_1 approaches infinity and/or λ_1 approaches zero the stronger would be the strength of fiscal over monetary policy to affect aggregate income. By Keynes' assumptions, β_1 is relatively high and λ_1 is relatively low, hence government expenditures exert a more powerful force on income than do changes in the supply of money.

Since the Keynesian revolution in economic theory, economists have held that ideally monetary policy should be used as a "fine tuning" mechanism in correcting minor deviations of the actual from the desired growth path. The structural setting in which monetary policy should be used is determined by fiscal policy. The reasons cited for such a "division of duties" are the ability of the monetary authorities to respond to economic deviations much more quickly than congressional or legislative bodies, the more general impact of monetary policy relative to the specialized or discriminatory impact of fiscal policy, and the relative weakness of monetary versus fiscal policy. These reasons for maintaining monetary policy as a "fine tuning" mechanism have, of course, come under attack from the "monetarist" economists, specifically questioning the ultimate effect of monetary policy on economic activity and the length and variability of the "lag in effect" of monetary policy. The former controversy is our main concern in this paper; the reader is referred to Friedman (1961) and Tucker (1966) for a discussion of the lag in effect of monetary policy.

From a theoretical standpoint, the strength and reliability of monetary policy hinges upon the degree of substitution between money and financial assets and between financial assets and real assets; that is, upon the degree of substitution among the different assets that must be described in giving a full outline of the monetary mechanism. This, in turn, depends upon the variables necessary to describe the demand for money.

In support of the high interest elasticity of the demand for money, Keynesian theorists would argue that only a narrowly defined group of financial assets are close substitutes for money balances; thus, a change in the money supply would be expected to have a small effect on interest rates on substitute financial assets because a small differential in yields between these assets and money would cause shifts in asset holdings which would again equalize the yields of money and the substitute financial assets. These shifts in asset holdings would be confined, primarily, to the holdings of money and the financial assets held as close substitutes for money. A change in the supply of money would cause relatively minor changes in the interest rates on financial assets, and these interest rate changes would cause an offsetting change in the quantity of money demanded. Changes in the money supply, then, would indirectly affect expenditures through changes in the interest rates on money substitutes, narrowly defined; but the expenditures effect would be small because the interest rate changes on financial substitutes for money would be small and the elasticity of expenditures with respect to such interest rate changes is low.

If, however, a wide range of assets, financial and real, are viewed as substitutes for money, then a change in the supply of money would have a <u>direct effect</u> upon expenditures as people adjust their holdings of real assets. Secondly, the changed interest rates on financial assets brought about through open-market operations would not cause an offsetting change in the demand for money which would change the ratio of money holdings to incomes, but rather, the return to equilibrium would be through changed demands for a wide range of real and financial assets. Thus, a change in the money supply would not be fully absorbed into the demand for money but would cause portfolio adjustments in real asset holdings (expenditures). This argument--the higher elasticity of expenditure on real assets and lower elasticity of the demand for money with respect to interest rate changes on financial asset substitutes--is a primary theoretical contention of the "monetarist" school of thought.

The Tobin Contribution

In the strict interpretation of the Keynesian adjustment mechanism, bonds, i.e., government debt, were the only substitute for money holdings. While the works of Haberler (1941) and Pigou (1943) had introduced wealth as a factor in the demand for money, its significance in a portfolio sense was based on a theory of optimal inventory holdings. Baumol (1952) applied the theory to inventories of money and finally related the demand for money to the volume of nonfinancial transactions and to yields on alternative assets. This was an early introduction to the portfolio selection approach to the demand for money and a return to the liquidity preference ideas put forth by Hicks much earlier. These ideas were more formally written, then, by Markowitz (1959) and James Tobin (1958, 1965).

The portfolio approach to monetary adjustments has been erroneously cited as the distinguishing factor between the

Keynesian and the monetarist or neoquantity economists. But clearly Keynes allowed for changes in the portfolio holdings of bonds and the effects of other asset holdings on the demand for bonds. Likewise, Friedman (1956, 1970), as the major exponent of the neo-quantity approach, allows for a portfolio adjustment process in response to wealth effects of monetary policy. The real distinction between the two is their differing views on the asset money. In Friedman's view, money is simply another way of holding value or purchasing power, and money has a comparative advantage in fulfilling transactions needs. Hence, it fits into the portfolio as an asset whose primary yield is convenience in transactions. Keynes, on the other hand, gives much more weight to the comparative advantage of money. Keynes holds money to be, in a portfolio sense, fulfilling a different role from all other assets except perhaps bonds; money, then, is more unique, in having fewer substitutes, in a Keynesian framework.

The Theoretical Issue

The test of the strength and reliability of monetary policy, then, lies in the range of assets considered to be substitutes for money holdings and in the degree of substitution between these assets in the portfolio. One can think of all asset holdings as part of a portfolio, but only a portion thereof as being substitutes in a financial portfolio sense. If the range of substitutes is very wide, encompassing at the limit the entire portfolio, then the degree of substitution along the spectrum from financial to real assets would be low; then the interest rate changes brought about by the monetary authorities would be quite large, and the effects of such interest rate changes on aggregate income would be stronger insofar as an increase in the money supply will be absorbed into money holdings to a lesser extent than if the range of money substitutes was narrow and the degree of substitution between money and such substitutes was high.

To clarify the issue, I propose the following example of the Keynesian monetary mechanism as altered by Tobin. Suppose the monetary authorities increase the supply of money (M^s) through open market purchases of public debt. These purchases cause a disequilibrium in the money market; the supply of money exceeds the demand for money (M^d). In response to the excess of actual over desired money balances, households seek to restore the equilibrium by reducing money holdings because the cost of holding the excess money (not using the money for purchases of other assets and their foregone earnings) outweighs its return (convenience for transactions).

Now the households can reduce cash balances in many ways.

They can, for instance, purchase bonds, other financial assets, real assets, or consumer goods. From a utility maximization standpoint, we might expect that households initially adjust their expenditures on very close substitutes for money; i.e., bonds. Likewise, from a portfolio analysis we might expect the excess money to be spent on bonds because, after all, this is the asset which has an excess demand due to the open market purchases. In fact, Friedman himself would likely view bonds as the first step in disposing of excess money balances; he would not feel restricted to bonds, however. In our portfolio analysis, Keynes would argue that only a few financial assets are viewed by households as close substitutes for money, and the substitutability of bonds for money is very strong because of the comparability of liquidity, risk, and yield. Thus, at least initially, the nod is given to purchase more bonds causing the price of bonds (P_b) to be driven up and the rate of return on bonds (r_b), viewing bonds as consols with fixed money return coupons attached, to be driven down.

As the rate of return on bonds declines, the demand for money would increase because cash is now relatively less costly to hold than before. This increase in the quantity of money demanded could be fully compensating of the excess supply of money if the interest elasticity of the demand for money were infinite. An infinite interest rate elasticity would, of course, mean that monetary policy would be totally ineffective because any change in the supply of money would have no effect on aggregate income; the excess money would be absorbed into money holdings. Empirical evidence on the interest elasticity of the demand for money, however, is conclusive that the elasticity is not $-\infty$ but most likely in the range -.2 to -1.0. (Some studies on the interest elasticity of the demand for money are reviewed in Appendix I of Goodhart and Crockett, 1970).

If the increase in the demand for money was not fully balancing, then we must introduce further substitution in the portfolio balancing process and aggregate income (Y) will be affected to some degree. In a typical Tobin fashion, we could say that the reduction in bond yields caused equities (E) to become relatively more attractive, and thus, more equities were demanded causing the price of equities (P_E) to increase and the rate of return on equities (r_e) to decline. The decline in the rate of return on equities or the cost of capital would induce investment (I) and increase income.

The increased income would now cause the demand for money to increase directly and indirectly, insofar as increased income would cause increased consumption, and this increased consumption would cause income to again increase in a multiplier fashion.

This mechanism diagrammatically appears as:

$$\begin{tikzcd}
M^s\uparrow \arrow[r] & (M^s > M^d) \arrow[d] & & & & & & \\
& r_b\downarrow \arrow[d] \arrow[rrrrrr] & & & & & & (M^s - M^d)\downarrow \\
& \frac{(r_b)}{(r_e)}\downarrow \arrow[r] & P_E\uparrow \arrow[r] & r_e\downarrow \arrow[r] & \frac{r_e}{MEC}\downarrow \arrow[r] & I\uparrow \arrow[r] & Y\uparrow \arrow[r] \arrow[d] & (M^s - M^d)\downarrow \\
& & & & & & C\uparrow \arrow[r] & Y\uparrow
\end{tikzcd}$$

where:

M^s = money supply

M^d = money demand

r_b = rate of return on bonds

r_e = rate of return on equities

P_e = price of equities

MEC = marginal efficiency of capital

I = investment

C = consumption

Y = aggregate income.

Or, in general, we could say that the money mechanism calls for a readjustment of portfolio holdings by purchasing money substitutes along a spectrum of decreasing substitutability, where the purchase of each asset leads to an increase in the price and a decline in the rate of return on that asset.

The substitution finally causes the return on capital to exceed the cost of capital and induces investment.

More recent literature (Tobin, 1969) has focused on the details of the mechanism whereby a discrepancy between the rate of return on equities (r_e) and the return on capital (MEC) stimulates investment. A brief description is presented.

An increase in the stock of money has several portfolio effects. The first effect is to reduce the "in-kind" yield of money holdings because cash balances are, ceteris paribus, larger than required for transactions balances. Secondly, the larger is the proportion of total wealth held in the form of any single asset, the greater is the risk, and lower the utility, of possible losses due to price changes. Thus, the yield on cash balances relative to the yield on other asset holdings, say capital, decreases. The discrepancy between the yield on money holdings and the yield on capital causes the price of existing capital to be bid up and narrows the price differential between new capital and existing capital thus stimulating investment. The important point is that we should expect the prices of existing capital goods, whether directly affected by money--capital portfolio shifts, or indirectly via bond-equity-capital portfolio shifts, to increase with increases in the supply of money.

This rather direct effect upon the price of existing capital and the ensuing increase in the rate of investment resulting from an increase in the supply of money can be envisioned as:

$$M^S\uparrow \;\rightarrow r_m\downarrow \;\rightarrow \frac{r_m}{r_k}\downarrow \;\rightarrow P_{ke}\uparrow \;\rightarrow \frac{P_{ke}}{P_{kn}}\uparrow \;\rightarrow I\uparrow$$

where:

r_m $\equiv$ the yield on money holdings

r_k $\equiv$ the yield on capital

P_{ke} $\equiv$ the price of existing capital

P_{kn} $\equiv$ the price of new capital

I $\equiv$ investment.

Testing Possibilities and Previous Tests

The economic problem, from a policy standpoint, is to determine the degree of substitution among portfolio assets in order to assess the importance of control over the money stock. The common method of estimating such substitution relationships is to evaluate the cross-elasticity of demand between the assets in question; i.e., to estimate, over time, the percentage change in the quantities demanded of the two assets in response to various percentage changes in the relative prices (rate of interest). The most common test of the importance of money, then, has been to measure the degree of responsiveness of money balances to changes in the interest rates on other financial assets considered to be close substitutes for money balances. Some of these tests of the interest elasticity of the demand for money are summarized in Appendix B. This testing procedure may be considered a direct test insofar as the dependent variable is the demand for money balances.

A second testing procedure less direct insofar as the test measures the substitutability between two nonmoney assets in the portfolio has almost been ignored in relative frequency to primary tests. This type of test has the advantage of avoiding several of the theoretical arguments inherent to primary tests; for instance, whether the money balances should be narrowly or broadly defined. On the other hand, new questions arise concerning which assets should be considered substitutes; but on balance, the indirect testing procedure must be considered at least as reliable as the direct procedure for the following reasons:

a) Any valid substitution relationship detected is meaningful because, after all, all goods in a portfolio are to some extent substitutes.

b) There seems to be some general agreement on the fact that monetary policy will have rather immediate initial effects in the markets for financial assets. Hence, a strong substitution between such financial assets and real assets would indicate a _potentially_ major role for monetary policy because monetary authorities _can_ affect financial markets.

c) The monetary effects on income, it is agreed, are transmitted through attempts to balance the portfolio rates of return at the margin, and monetary policy affects _both_ the return on money and financial assets; i.e., interest rate transmissions.

d) Most economists are agreed that the strength of monetary policy depends upon the degree of substitution between financial assets and real assets. Thus, an indirect test relative to the effect of portfolio substitutions on money balances is really a direct test of the economic question--the strength of monetary policy.

Why Land?

In a portfolio analysis framework, one test of the effectiveness of monetary policy in the transmission mechanism presented is the extent to which substitution among portfolio assets, in response to a change in interest rates brought about through open-market operations, affects the cost of capital. Tobin (1965) emphasizes relative yields and relative risks among assets as primary factors determining the extent of substitution among assets in a portfolio.

The portfolio problem is really one of maximizing a portfolio yield subject to risk constraints. We could state the objective function as:

$$Y = X_1Y_1 + X_2Y_2 + \ldots + X_nY_n$$

where Y is the total portfolio yield, Y_i is the yield of the i^{th} asset in the portfolio, and X_i is the proportion of the portfolio held in the i^{th} asset. The measure of risk recommended by Tobin is the standard deviation (σ) of the yield series; thus, the risk constraint could be written:

$$\sigma^2_{1\cdot2\cdot3\ldots n} = X_1^2\sigma_1^2 + X_2^2\sigma_2^2 + \ldots + X_n^2\sigma_n^2 + 2X_1X_2\rho_{1\cdot2}\sigma_1\sigma_2$$

$$+ 2X_1X_3\rho_{1\cdot3}\sigma_1\sigma_3 + \ldots + 2X_nX_{n-1}\rho_{n\cdot n-1}\sigma_n\sigma_{n-1}$$

where ρ_{ij} is the correlation coefficient between the yields on asset i and asset j, and, of course, the final constraint requires the sum of the X_i to equal one (1).

In this context, the substitution between nonmoney financial assets and real assets is the most important substitution relationship for the effectiveness of monetary policy. Agricultural land is one form of capital that may be considered closely substitutable for the financial assets bonds and equities based upon the similarities in risk and yield of the assets.

Intuitively, land seems to be an investment of relatively low risk, like bonds, when one considers the appreciation record of land. Since 1940, the average value of land per acre for the United States was decreased in only three years. More recent experience shows the price of land increasing from $69 per acre in 1950 to $195 per acre in 1970. And, while land holdings are less liquid and divisible than bond holdings, it can be viewed as an investment of long-term nature; i.e., similarity in investment duration. It may be noted that the rise of corporate farming makes land investments more liquid and divisible in organized exchanges. This development allows the cost of capital in agriculture to be affected by the monetary authorities in exactly the same manner as it is affected, as envisioned by Tobin, and Modigliani and Miller (1958), in other industries through corporation finance decisions.

Tobin's "General Equilibrium Approach to Monetary Theory" (1969) gives another justification for including the bond return in the demand for farm real estate. Tobin argues that, in a general equilibrium framework, all of the interest rates relevant to the assets in a portfolio must appear in the demand function of each asset in the portfolio because the total change of asset holdings in the portfolio, in response to a change in a particular interest rate, must be zero. For this reason, Tobin argues that an insignificant effect of a particular interest rate change upon another portfolio asset doesn't mean that the interest rate in question should be omitted because the effects may be distributed in such a manner that they seem individually insignificant but have significant effects on the total portfolio holdings.

A final reason for using land in testing the effects of monetary policy relates to the substitutability of land and capital. The mechanism envisioned to describe the effects of monetary policy requires changes in the price of capital. From an empirical testing standpoint, we are lost as to what series of data should be used for the price of capital. Insofar as agricultural land is a substitute for, indeed one form of, physical capital, land prices may be used as a proxy for the price of existing capital. This paper includes a simple model in which the price of land is used in such a manner, and the results of this test are included in Chapter III.

CHAPTER II. THE DEMAND FOR FARM REAL ESTATE

This chapter develops two models of the demand for farm real estate in the United States. The first is a simple, single equation model reflecting the demand for agricultural land as a portfolio asset, and this model is suitable for testing the elasticity of the price of farm land with respect to interest rate variations on competing assets, again in a Tobin portfolio sense. The second model is a three market portfolio-type model patterned after the asset market model of Foley and Sidrauski (1971) and Tobin (1969).

Model I--Land as a Competitive Asset

Average land prices in the United States have increased near 300 percent since 1950 while average farm incomes have increased by less than 100 percent. This evidence casts some doubt on the hypothesis that the demand for land is primarily a function of its rate of return. Clearly, if net farm income is used as a proxy for the residual rate of return imputed to land, it does not explain the increases in land prices since 1950.

A popular alternative hypothesis suggested by some agricultural economists is that the price increases are a result of an excess demand for farm land in farm enlargement programs. This hypothesis is based, in part, on the fact that regressions of land price on net income from farming gave fairly good statistical fits prior to 1952, but after that time, changes in net income or increased nominal yields to land holders failed to explain the land price spiral. In response to these findings, the farm enlargement hypothesis stated that farmers were clamoring for land as a noncompeting asset, that is, without regard to the yield on land or the yield on land relative to the yield on other assets.

Other hypotheses could be advanced relating the price of agricultural land to such factors as the machinery stock; cropping practices; the location of the land; quality of access roads; capitalized benefits of farm programs tied to acreage restrictions; land taxes; the supply of farm labor; speculation on anticipated appreciation in land values; population growth; the number of farms; the number of nonoperator farm owners; the farm financial structure, such as the ratio of farm real estate debt to equity, the quantity of farm liquid assets, and the proportion of farm real estate debt held by various lenders; and the return available on competing assets.

The portfolio hypothesis of the determination of land price variations proposed in Model I is exactly opposite the farm enlargement hypothesis in treating farm land as a competing asset with other forms of investment. It seems economically unlikely that farm investors, operator or non-operator, purchase land without regard to its yield, as well as competitive yields, in an investment portfolio. One could argue that since 1952 the role of competitive assets in the determination of land values has increased, and this helps to explain why the yield on farm land has failed to explain land price variations.

From the aforementioned list of variables affecting the price of farm real estate, the most relevant in a portfolio analysis are the yield on land; the anticipated appreciation in land values, i.e., the expected capital gains from holding land; and the yield on competitive assets. We could simply state that:

$$P = f(Y, CG, R) \tag{2.1}$$

where

P = the price of farm real estate

Y = a measure of the yield on land

CG = a measure of the capital gains, expected or realized, from holding land; and

R = some measure of the return on assets competitive to farm real estate as an investment.

More of the listed variables could be included in a more complex model of several equations estimated recursively. The simplicity of the above model lies in having only presumably exogenous variables to a single dependent variable making ordinary least-squares appropriate for estimation. The model may, in fact, appear too simple for prediction purposes insofar as it considers only one-half of the market for farm land, the demand, and it neglects supply factors. The simplicity gained, however, seems to outweigh any loss of accuracy in prediction on this count because for any given year the supply of land can be considered fixed. Obviously, the supply of agricultural land changes over time through clearing and irrigation projects, changes in government farm programs, and urbanization and industrialization, but the effects of such changes on the total supply of farm real estate are expected to be negligible.

Alternative Specifications

The demand function may be specified in several ways depending upon the specific measures used to represent the various effects and the assumed mathematical properties of the function itself.

There are several measures for the yield from holding farm real estate, each with its own merits. Gross farm income, for example, is a commonly used proxy for the residual return to land, but an average of gross farm incomes over the current and several previous periods could also be used on the assumption that investors are more concerned with the mean return or the expected return than the more variable return of a given year. Another commonly used series for the yield on agricultural land is the gross farm income of the previous year. The rationale for this lag lies in the timing of data reporting on the price of land and the realization of farm income. Land values are recorded as of March 1st each year and farm income is reported on December 31st. Thus, the most direct effect that farm income could have on land values is with a one-year lag.

The general demand function (2.1) was fitted in linear form for specified periods with the following variations in data representing the yield on farm real estate: the residual dollar yield to farm real estate ($RY) calculated as the residual of net farm income in return to farm real estate after imputing returns to production labor, operator's management, and nonreal estate farm capital; a simple three-year average of the residual dollar yield to farm real estate of the current and two previous periods ($RY*), gross farm income per acre (GFY), and a three-year simple average of the gross farm income per acre over the current and two previous years (GFY*). (See Appendix for sources and description of data.) We should, of course, expect the price of farm real estate to vary directly with the yield on farm real estate.

The price of farm real estate is expected to vary directly with the expected appreciation in land values, that is, with the capital gains from holding farm real estate. One procedure for building expectations into a model is to make the expected value of CG a weighted average of current and past values of that variable. The weights may be established as values of some polynomial of given degree or arbitrarily chosen (see Tweeten and Martin, 1966). Or, the present and past values of the independent variables may be treated separately allowing the coefficients to be established by least-squares.

The measures for the capital gains variable in fitting the linear demand for farm real estate were: the current year's capital gain (CG_t) calculated simply as the change in the price of farm real estate (measured in current dollars) from the previous year, the capital gain over the current year and the two previous years, and a simple three-year average of capital gains over the current and two previous years

$$(CG^* = \frac{CG_t + CG_{t-1} + GC_{t-2}}{3}) \quad .$$

The price of land should vary inversely with the yield on competitive assets. In maximizing the total utility from an investment portfolio, we expect the investor to equate the marginal utility of the last dollar invested plus the marginal disutility of risk associated with that investment for all assets in the portfolio (see Floyd, 1972). Considering farm real estate and one other competitive asset, we should expect that portfolio shifts will be undertaken until the marginal utility from income of land relative to the marginal disutility of risk associated with land holdings is equal to the marginal utility of income from the competitive asset relative to the marginal disutility of risk of holding that asset. Thus, an increase in the return on competitive assets should cause investors to shift into those assets until the marginal conditions are restored. This means that either the dollar yield on farm real estate must increase, or alternatively, the price of farm land must decrease, in order to increase the rate of return on farm real estate.

Perfect substitutability between farm land and, say, equities, in the absence of transactions costs and imperfect information, would imply that the elasticity of farm real estate values with respect to the rate of return on equities should be -1.0, that is, if the return on equities increases, the price of farm land (dollar yield constant) must undergo an equal percentage reduction. For R, the yield on competitive assets, the linear model was fitted with Standard and Poor's corporate divident/price ratio.

As a second test of the elasticity of farm real estate values with respect to the independent variables and to allow for a more flexible mathematical specification, the model was respecified in log-linear form as:

$$\ln P = \alpha_0 + \alpha_1 \ln Y + \alpha_2 \ln CG + \alpha_3 \ln R + e \qquad (2.2)$$

where the α_i are least-squares coefficients interpreted, of course, as elasticities and e is the error term. The results of both the linear and log-linear specifications are reported in Chapter III.

Model II--Land as a Proxy for Capital

One other model was suggested for testing the possibility of using the rate of return on farm real estate as a proxy for the return to capital in a macroeconomic model. The model presented here is a simple three market variant of the Tobin (1969) and Foley and Sidrauski (1971) type where the effects of monetary policy are transmitted through the price of capital affecting the equilibrium in the assets markets.

The three markets in this model are the markets for money (M), bonds (B) and capital (K). Wealth, measured in current commodity prices may then be written:

$$W = \frac{KP_k}{P} + \frac{BP_b}{P} + \frac{M}{P} \tag{2.3}$$

where

K = the real stock of capital, fixed at any point in time through past savings and capital accumulation decisions

B = the stock of privately held interest-bearing government debt, fixed at any point in time as the result of past government deficits; and

M = the monetary base. Commercial and mutual savings banks are "inside" this system as one type of private investor; thus, B includes interest-bearing public debt securities held by banks and M is "high-powered money." This makes M the supply of money to the private sector inclusive of banks.

P_k = average market value of a unit of capital held by the private sector,

P_b = average market price of a unit of government debt (bond) held by the private sector.

At any point in time, the quantities of money, bonds, and capital demanded in the portfolios of wealth owners depend on their wealth (W), the vector of real rates of return on money, bonds, and capital (ρ_m, ρ_b, ρ_k) and the aggregate level of income of the wealth owners measured in real terms (Y).

The demand functions for the three assets could be written then as:

$$\frac{M^d}{P} = f_1(Y, \rho_m, \rho_b, \rho_k, W) \qquad (2.4)$$

$$\frac{B^d P_b}{P} = f_2(Y, \rho_m, \rho_b, \rho_k, W) \qquad (2.5)$$

$$\frac{K^d P_k}{P} = f_3(Y, \rho_m, \rho_b, \rho_k, W) \tag{2.6}$$

Assume that an increase in the level of real income increases the demand for money (a transactions demand) at the expense of both bonds and capital, i.e.,

$$1 \geq \frac{\delta f_1}{\delta Y} \geq 0 \quad , \quad \frac{\delta f_2}{\delta Y} \leq 0 \quad , \quad \frac{\delta f_3}{\delta Y} \leq 0 \quad ;$$

and an increase in real wealth increases the demand for all assets, i.e.,

$$\frac{\delta f_i}{\delta W} \geq 0 \quad \text{for all} \quad i=1,2,3 \quad .$$

Further, we expect that an increase in own real rate of return increases the demand for that asset at the expense of the other two, that is, the assets are assumed to be gross substitutes.

From the wealth constraint (2.3) the demand function partials are further restricted such that

$$\sum_{i=1}^{3} \frac{\delta f_i}{\delta W} = 1 \quad ,$$

$$\sum_{i=1}^{3} \frac{\delta f_i}{\delta Y} = 0 \quad , \quad \text{and}$$

$$\sum_{i=1}^{3} \frac{\delta f_i}{\delta \rho_j} = 0 \quad , \quad j=k,b,m.$$

The demand functions for the three assets could now be written in linear form as:

$$\frac{M^d}{P} = \alpha_o + \alpha_1 Y + \alpha_2 \rho_m + \alpha_3 \rho_b + \alpha_4 \rho_k + \alpha_5 W \tag{2.7}$$

$$\frac{B^d P_b}{P} = \beta_o + \beta_1 Y + \beta_2 \rho_m + \beta_3 \rho_b + \beta_4 \rho_k + \beta_5 W \tag{2.8}$$

$$\frac{K^d P_k}{P} = \gamma_o + \gamma_1 Y + \gamma_2 \rho_m + \gamma_3 \rho_b + \gamma_4 \rho_k + \gamma_5 W \quad . \tag{2.9}$$

where the vector of real rate-of-return equations are:

$$\rho_m = r_m - \frac{\Delta P}{P} \quad , \tag{2.10}$$

$$\rho_b = r_b - f\left(\frac{\Delta r_b}{r_b}\right) - \frac{\Delta P}{P} \quad , \quad \text{and} \tag{2.11}$$

$$\rho_k = r_k + \frac{\Delta P_k}{P_k} - \frac{\Delta P}{P} \quad , \tag{2.12}$$

where

r_m = the nominal return from a unit of money, institutionally zero,

r_k = the "rental rate" of a unit of capital, equal to the value of the marginal product of capital relative to the price of capital,

$\frac{\Delta P}{P}$ = the expected rate of change in commodity prices,

r_b = the nominal rate of return on bonds assumed to have a fixed nominal yield,

$\frac{\Delta r_b}{r_b}$ = the rate of change in r_b,

$\frac{\Delta P_k}{P_k}$ = the rate of change in P_k, and

f is a function such that $f' > 0$.

The nominal return on money is zero, but there is still the possibility of capital gains and losses on money holdings due to changes in the price level. Increases in the general level of prices reduce the purchasing power of money holdings and, hence, the real rate of return on money. Equation 2.11 expresses the fact that bond holders recognize decreases in the real rate of return on bonds from the nominal rate when the nominal rate increases because increases in r_b result in capital losses due to decreases in P_b. And, like money, bonds suffer a reduction in real yield when the purchasing power of the nominal return is decreased by inflation. Finally, the real rate of return on capital depends upon the rental rate, changes in the purchasing power of the rental income, and capital gains or losses due to changes in P_k.

Substituting Equations 2.10, 2.11, and 2.12 into Equations 2.7, 2.8, and 2.9 we have four equations (three real demand functions plus the wealth constraint) and three unknowns;

$$\frac{M^d}{P}\ , \quad \frac{B^d P_b}{P}\ , \quad \text{and} \quad \frac{K^d P_k}{P}\ .$$

But only three of the four equations are independent because given any two of the demands, the third can be found from the wealth constraint. We could, then, eliminate any one of the demand functions, say, the demand for capital. Thus, we have three independent equations (2.3, 2.7, and 2.8) in three unknowns

$$\left(\frac{M^d}{P}\ , \quad \frac{B^d P_b}{P}\ , \quad \text{and} \quad \frac{K^d P_k}{P}\right)\ .$$

Substituting for ρ_b and ρ_m and arranging terms, the solution for r_k is:

$$r_k = \frac{\beta_3\alpha_0 - \alpha_3\beta_0}{\Phi} + \frac{\beta_3(\alpha_5 - 1) - \alpha_3\beta_5}{\Phi}\frac{M^d}{P}$$
$$+ \frac{\alpha_3(1-\beta_5) + \beta_3\alpha_5}{\Phi}\frac{B^d P_b}{P} + \frac{\beta_3\alpha_1 - \alpha_3\beta_1}{\Phi}Y$$
$$+ \frac{\beta_3\alpha_5 - \alpha_3\beta_5}{\Phi}\frac{K^d P_k}{P} - \frac{\Delta P_k}{P_k} + \left[1 + \frac{\alpha_3\beta_2 - \beta_3\alpha_2}{\Phi}\right]\frac{\Delta P}{P}\ , \tag{2.13}$$

where $\Phi = \alpha_3\beta_4 - \alpha_4\beta_3$ is a positive constant since $\alpha_3 < 0$, $\beta_4 < 0$, $\alpha_4 < 0$, and $\beta_3 > 0$. Assuming that α_5 and β_5 are greater than zero but less than one, the signs of the coefficients are indeterminate for

$$\frac{B^d P_b}{P} \ , \ \frac{M^d}{P} \ , \ Y \ , \text{ and } \frac{\Delta P}{P} \ .$$

The sign for

$$\frac{K^d P_k}{P}$$

is positive, and the sign for

$$\frac{\Delta P_k}{P_k}$$

is negative.

The hypothesis is that the rate-of-return on farm real estate and variations in that rate should be a good proxy for the rate-of-return on capital. The support for this hypothesis rests in the expected investment competition between land and other forms of capital and in the importance of land as one form of capital.

Substituting, then, the price of farm real estate, the rate of return on farm real estate, and the rate of change in farm real estate prices for the price of capital, the rate of return on capital, and the rate of change in capital prices (2.13) becomes:

$$r_L = \frac{\beta_3\alpha_o - \alpha_3\beta_o}{\Phi} + \frac{\beta_3(\alpha_5 - 1) - \alpha_3\beta_5}{\Phi}\frac{M^d}{P}$$

$$+ \frac{\alpha_3(1-\beta_5) + \beta_3\alpha_5}{\Phi} \frac{B^d P_b}{P} + \frac{\beta_3\alpha_1 - \alpha_3\beta_1}{\Phi} Y$$

$$+ \frac{\beta_3\alpha_5 - \alpha_3\beta_5}{\Phi} \frac{K^d P_k}{P} - \frac{\Delta P_L}{P_L} + [1 + \frac{\alpha_3\beta_2 - \beta_3\alpha_2}{\Phi}] \frac{\Delta P}{P} \tag{2.14}$$

where the expected signs are the same as before.

Now letting the income from farm real estate relative to the price of farm real estate be r_L, we have a model suitable for testing the use of farm land as a proxy for capital.

We assume, of course, that at any point in time the demand for each asset is equal to its observed supply so that

$$M^d \equiv M^s \quad , \tag{2.15}$$

$$B^d = B^s \quad , \quad \text{and} \tag{2.16}$$

$$K^d = K^s \quad . \tag{2.17}$$

These substitutions into Equation 2.14 allow us to work with observable quantities.

CHAPTER III. EMPIRICAL RESULTS

Model I

The empirical results from model I shed some light on the degree of substitution between farm real estate as one form of real investment expenditures and financial assets. The importance of this type of substitution is, again, that if the substitution between financial assets and real assets is relatively strong this suggests that the return to equlibrium in response to a change in the supply of money is not confined to financial markets, but rather the return to equilibrium is through changed demands for a much wider range of financial and real assets. Such a substitution relationship implies, then, that a change in the money supply has a direct effect, a portfolio effect, upon expenditures, and further, that the expenditures on real assets are quite sensitive with respect to interest rate changes on financial assets. This is, of course, the "monetarist" contention which is contrary to the strict interpretation of Keynesian theory.

The results from fitting model I in linear form for the post-war period by ordinary least squares are presented in Tables 3.1 to 3.4.

These results suggest that the yield on farm real estate, as proxied by either the residual dollar yield on land or

Table 3.1 Ordinary least-squares regression of:
$P = f(\$RY_{t-1}, CG_t, CG_{t-1}, CG_{t-2}, D/P)_{1952-70}$

Equation	Constant	Independent Variables[a]			
		$\$RY_{t-1}$	CG_t	CG_{t-1}	CG_{t-2}
3.1.1	60.484	13.704 (3.333)**			
3.1.2	60.734	10.250 (2.251)*	2.477 (1.106)		
3.1.3	133.68	3.614 (1.253)	2.620 (2.091)	1.339 (1.334)	2.807 (2.768)*

[a]Figures in parentheses are t-statistics. This is true for the following tables also.

**Significant at .01 level. This is true for the following tables also.

*Significant at .05 level. This is true for the following tables also.

Table 3.2. Ordinary least-squares regression of:
$P = f(\$RY^*, CG_t, CG_{t-1}, CG_{t-2}, D/P)_{1952-70}$

Equation	Constant	Independent Variables[a]			
		$RY*	CG_t	CG_{t-1}	CG_{t-2}
3.2.1	38.912	19.164 (6.512)**			
3.2.2	43.054	14.525 (3.659)**	2.771 (1.652)		
3.2.3	119.04	8.875 (2.230)*	2.095 (1.448)	0.342 (0.259)	2.185 (2.125)*

D/P	Mean Elasticity P w.r.t. D/P	Mean Elasticity P w.r.t. $\$RY_{t-1}$	R^2	Durbin-Watson d
		0.511	0.484	0.554
		0.383	0.518	0.542
-17.151 (-4.669)**	-0.536	0.135	0.899	1.092

D/P	Mean Elasticity P w.r.t. D/P	Mean Elasticity P w.r.t. \$RY*	R^2	Durbin-Watson d
		0.692	0.706	0.330
		0.524	0.757	0.522
-16.153 (-3.379)**	-0.480	0.320	0.903	0.669

Table 3.3. Ordinary least-squares regression of: $P = f(GFY_{t-1}, CG_t, CG_{t-1}, CG_{t-2}, D/P)_{1952-70}$

Equation	Constant	Independent Variables[a]			
		GFY_{t-1}	CG_t	CG_{t-1}	CG_{t-2}
3.3.1	-66.614	5.252 (15.895)**			
3.3.2	252.23				
3.3.3	-57.303	4.826 (9.813)**	1.103 (1.186)		
3.3.4	-62.268	5.082 (9.439)**	1.374 (1.441)	-0.972 (-1.122)	
3.3.5	0.864	4.325 (9.616)**	0.494 (0.662)	0.231 (0.320)	
3.3.6	9.669	3.932 (6.751)**	0.860 (1.048)	0.210 (0.292)	0.653 (1.057)

Table 3.4. Ordinary least-squares regression of: $P = f(GFY^*, CG_t, CG_{t-1}, CG_{t-2}, D/P)_{1972-70}$

Equation	Constant	Independent Variables[a]			
		GFY*	CG_t	CG_{t-1}	CG_{t-2}
3.4.1	-70.515	5.384 (23.532)**			
3.4.2	-22.885	4.854 (26.969)**			
3.4.3	-61.012	4.920 (16.221)**	1.202 (2.107)*		
3.4.4	-65.379	5.151 (16.681)**	1.502 (2.704)**	-0.945 (-1.852)	
3.4.5	-20.858	4.582 (18.795)**	0.934 (2.372)*	-0.988 (-0.252)	
3.4.6	-16.486	4.410 (13.502)**	1.070 (2.470*	-1.000 (-0.249)	0.277 (0.803)

D/P	Mean Elasticity P w.r.t. D/P	Mean Elasticity P w.r.t. GFY_{t-1}	R^2	Durbin-Watson d
		1.527	0.841	0.814
-31.007 (-3.859)**	-0.722		0.466	0.267
		1.401	0.941	0.983
		1.475	0.943	1.414
-10.012 (-3.646)**	-0.298	1.255	0.971	1.583
-10.084 (-3.687)**	-0.300	1.141	0.975	1.676

D/P	Mean Elasticity P_L w.r.t D/P	Mean Elasticity P w.r.t. GFY*	F^2	Durbin-Watson d
		1.560	0.970	0.400
-7.551 (-5.053)**	-0.225	1.406	0.986	0.886
		1.425	0.976	0.450
		1.492	0.980	0.960
-6.812 (-4.407)**	-0.203	1.327	0.992	0.913
-6.950 (-4.413)**	-0.207	1.277	0.992	0.947

gross farm income per acre of farm real estate, is significant in explaining farm real estate price variations in the post-war period. This finding is consistent with the hypothesis of model I, that farm land is an investment-competitive asset. The yield on farm land is significant in thirteen of fourteen regressions and always has the expected positive sign.

The mean elasticity of the price of farm real estate with respect to the residual dollar yield on land or its expectation as proxied by the average residual dollar yield is always less than 0.5, while the price elasticity with respect to gross farm income is nearer the expected value of 1.0 in all cases and equal to 1.14 for the full model with GFY_{t-1} and 1.28 for the full model with GFY*. Thus, the results using GFY as a proxy for the yield on land appear to support our hypothesis better than the results reported with $RY as the yield variable. Further, GFY has a higher significance than $RY in all specifications, and the R^2 is higher in regressions using GFY. These facts indicate that gross farm income per acre has more explanatory power, as an independent variable, than does the residual dollar yield to farm real estate. This is a rather surprising result as we should expect that $RY would more accurately reflect the yield to land than would GFY. The most plausible explanation for finding the opposite is that the residual nature of the $RY variable makes it much more susceptible to reporting and calculation errors.

The capital gains variables have the expected positive sign in all but three cases. In general, however, the capital gains coefficients were found to be insignificant, and the addition of lagged capital gains as independent variables did not significantly improve the R^2. In fact, when GFY_{t-1} was used as the yield on land variable, inclusion of the capital gains of the current period increased the R^2 from 0.841 to 0.941, but capital gains of the previous two periods increased the R^2 by less than one percent.

A most rewarding result is the expected negative sign and the high level of significance for the return on competitive assets variable, D/P. This variable was found to be significant at the 1 percent confidence level in all cases, suggesting that farm real estate is, in fact, competitive with other forms of investment. As previously noted, perfect substitution between farm real estate and equities would imply that the elasticity of farm real estate with respect to the yield on equities should be -1.0, and we note that the mean elasticity is always negative and is in the range -0.30 to -0.50 in the full model specifications. A mean price elasticity in this range is acceptable when we recognize transactions costs and indivisibilities as imperfections and when we note that this is an average elasticity.

The Durbin-Watson d statistic is inconclusive in testing for first order autocorrelation in the full model specified with $\$RY_{t-1}$, GFY_{t-1}, or GFY^* as the yield to farm land variable, but we reject the hypothesis of no autocorrelation when the full model is specified with $\$RY^*$ as the land yield variable ($d_L = 0.75$).

To examine the true elasticity of the price of farm real estate with respect to the yield on farm real estate and with respect to the yield on competitive assets, the model was specified in log-linear form. We expect that the rate of return on farm real estate should equal the rate of return on competitive assets, i.e.,

$$\frac{Y + CG}{P} = R \quad , \tag{3.1}$$

or alternatively,

$$\frac{Y + CG}{R} = P \quad . \tag{3.2}$$

Stated in log-linear form, then, we expect that

$$\ln P = \alpha_0 + \alpha_1 \ln(Y+CG) + \alpha_2 \ln R \quad . \tag{3.3}$$

This model was tested in actual and expected variables for Y and CG and with the dividend to price ratio representing the rate of return on competitive assets (R). The results are reported in Table 3.5. Clearly, the yield on land is a significant variable in explaining variations in the value of farm real estate as this variable always possesses the correct a priori sign and is always significant. More importantly, the regression coefficient, α_1, is the elasticity of the price of farm real estate with respect to the yield on farm real estate and α_2 is the elasticity of the price of farm real estate with respect to the rate-of-return on competitive assets. The expected values of these coefficients are 1.0 and -1.0, respectively, and, we note that in fact, α_1 is very close to 1.0 in all cases and a t-test fails to reject the hypothesis that $\alpha_1 = 1$ in all cases. The elasticity of P with respect to D/P (α_2), however, is less impressive at about -0.5, but this value is, again, certainly within an acceptable range of substitution under the hypothesis of the model. The lower elasticity with respect D/P suggests that, while farm real estate is viewed as a substitute for equities, investors do not view the two assets as perfect substitutes, possibly due to a risk differential or transactions costs, or perhaps investors do not recognize changes in D/P as being permanent in any one-year period. We note, however, that the competitive asset coefficient, α_2, is always negative, as expected, and is significant at the 1 percent confidence level in all cases.

The intercept term, α_o, can be interpreted as a measure

Table 3.5. Ordinary least-squares regression of: $\ln P = f[\ln(Y+CG), \ln R]_{1952-70}$

Eq.	Constant	Independent Variables[a] ln $(GFY_{t-1}+CG_t)$	ln $(GFY_{t-1}+CG^*)$	ln (GFY^*+CG_t)	ln (GFY^*+CG^*)	ln D/P	R^2	Durbin-Watson d
3.5.1	-0.166 (-0.507)	0.956 (9.33)**				-0.423 (-3.67)**	0.935	1.641
3.5.2	-0.477 (-1.73)		0.937 (12.17)**			-0.492 (-5.64)**	0.958	1.265
3.5.3	-0.191 (-0.70)			1.029 (11.78)**		-0.348 (-3.58)**	0.956	1.539
3.5.4	-0.483 (-2.19)*				1.030 (15.49)**	-0.437 (-6.11)**	0.956	0.981

of the imperfection of the hypothesized substitution relation. From Equation 3.3, if the substitution is perfect, the expected value of α_o is zero. Thus, a failure to reject the null hypothesis $\alpha_o = 0$ is consistent with the competitive asset hypothesis of model I. Table 3.5 shows a failure to reject the hypothesis that $\alpha_o = 0$ in three of four regressions, the only exception being when the yield on farm land is based completely on expectations from the current and previous two periods when the expected values of GFY and CG are proxied by averages over a three year, weights arbitrarily set at 0.333 for a simple average, some error is obviously introduced into the model which may increase the significance of α_o.

The failure to reject $\alpha_o = 0$ in most regressions suggests, again, that variations in the price of farm land may be explained by the yield on farm land and the yield on competitive assets.

The R^2 is 0.935 when the model is tested using actual values for all variables and climbs to 0.95 when some form of expectation is introduced into the model. This is an expected result because while the averaging over actual values may introduce specification error, the averaging does, nonetheless, reduce the variability in the expected variable from that of actual values by "smoothing out" the series.

The Durbin-Watson d statistic falls in the inconclusive range in all four regressions reported, but is acceptable at 1.641 when the model is tested with actual value variables, i.e., no expectations. The Durbin-Watson falls, of course, when expectations are introduced, particularly with a simple average of actual values, as the errors become more autocorrelated.

In total, these results appear conclusive that the yield on land and the rate of return on competitive assets explain the variations in the price of farm real estate in the period 1952 to 1970. Recognizing the dividend to price ratio as the monetary policy variable in this model, that is, assuming that the monetary authorities can affect the demand for equities through affecting the yield on bonds, these results also suggest a potentially strong effect on expenditures for monetary policy.

These results, again, support the portfolio hypothesis of the demand for farm real estate and are quite destructive of the farm enlargement hypothesis. To test the possibility of a change in the structure of the demand for farm real estate from the pre-1952 period, the same regressions were estimated over the period from 1939 to 1952. The results of these regressions are presented in Tables 3.6 to 3.9. The model was not run from 1939-52 with the residual dollar yield on land as an independent variable due to a lack of

Table 3.6. Ordinary least-squares regression of:
$P = f(GFY_{t-1}, CG_t, CG_{t-1}, CG_{t-2}, D/P)_{1939-52}$

Equation	Constant	Independent Variables[a]			
		GFY_{t-1}	CG_t	CG_{t-1}	CG_{t-2}
3.6.1	5.760	2.186 (10.951)**			
3.6.2	21.244				
3.6.3	6.017	2.149 (8.036)**	0.136 (0.214)		
3.6.4	3.591	2.390 (6.768)**	0.056 (0.087)	-0.738 (-1.042)	
3.6.5	-0.039	2.292 (5.103)**	0.162 (0.224)	-0.582 (-0.688)	
3.6.6	3.617	2.861 (4.908)**	-0.302 (-0.398)	-1.129 (-1.272)	-1.261 (-1.427)

Table 3.7. Ordinary least-squares regression of:
$P = f(GFY^*, CG_t, CG_{t-1}, CG_{t-2}, D/P)_{1939-52}$

Equation	Constant	Independent Variables[a]			
		GFY*	CG_t	CG_{t-1}	CG_{t-2}
3.7.1	2.866	2.320 (12.451)**			
3.7.2		2.28 (11.73)**			
3.7.3	3.310	2.260 (9.256)**	0.222 (0.401)		
3.7.4	2.281	2.361 (7.523)**	0.207 (0.361)	-0.332 (-0.542)	
3.7.5	-3.941	2.215 (5.868)**	0.360 (0.578)	-0.117 (-0.170)	
3.7.6	-0.526	2.911 (6.624)**	-0.16 (-0.292)	-0.662 (-1.065)	-1.606 (-2.256)

D/P	Mean Elasticity P w.r.t. D/P	Mean Elasticity P w.r.t. GFY_{t-1}	R^2	Durbin-Watson d
		0.891	0.908	0.668
5.819 (1.044)	0.597		0.084	0.160
		0.876	0.910	0.634
		0.974	0.918	0.769
89.212 (0.380)	0.091	0.934	0.920	0.119
-0.782 (-0.311)	-0.080	1.166	0.935	1.161

D/P	Mean Elasticity P w.r.t D/P	Mean Elasticity P w.r.t. GFY*	R^2	Durbin-Watson d
		0.946	0.927	0.505
1.31 (0.81)	0.134	0.931	0.931	0.545
		0.921	0.929	0.401
		0.962	0.931	0.486
1.50 (0.737)	0.153	0.903	0.936	0.451
-0.433 (-0.230)	-0.044	1.187	0.960	0.843

Table 3.8. Ordinary least-squares regression of: $P = f(GFY^*, CG^*, D/P)_{1939-52}$

Eq.	Constant	Independent Variables[a] GFY*	CG*	D/P	Mean Elasticity P w.r.t D/P	Mean Elasticity P w.r.t. GFY*	R^2	Durbin-Watson d
3.8.1	-0.965	2.745	-1.650			1.119	0.939	0.950
		(7.891)**	(-1.426)					
3.8.2	-3.429	2.283		1.313	0.135	0.931	0.931	0.545
		(11.732)**		(0.805)				
3.8.3	-0.564	2.761	-1.701	-0.108	-0.011	1.126	0.939	0.966
		(5.765)**	(-1.092)	(-0.052)				

Table 3.9. Ordinary least-squares regression of: $\ln P = f[\ln(Y+CG), \ln R]_{1938-52}$

Eq.	Constant	Independent Variables[a]					R^2	Durbin-Watson d
		ln $(GFY_{t-1}+CG_t)$	ln $(GFY_{t-1}+CG^*)$	ln (GFY^*+CG_t)	ln (GFY^*+CG^*)	ln D/P		
3.9.1	2.553	0.632				0.230	0.846	0.583
	(3.371)**	(7.602)**				(1.035)		
2.9.2	2.735		0.654			0.293	0.887	0.458
	(4.021)**		(8.744)**			(1.401)		
3.9.3	2.517			0.672		0.244	0.869	0.498
	(3.379)**			(8.235)**		(1.084)		
3.9.4	2.591				0.691	0.286	0.903	0.395
	(4.052)**				(9.686)**	(1.465)		

data and the previously expressed preference for gross farm income, based upon its explanatory power, as the yield on land variable.

The results for the period from 1939-1952 show, again, that the yield on farm real estate, as measured by the gross farm income per acre of farm real estate or its expectation, is highly significant in explaining variations in farm real estate prices. This coefficient always has the expected positive sign and is always significantly different from zero at the 1 percent confidence level. Further, the mean elasticity of the price of farm real estate with respect to the yield on farm land, however measured, is between 0.89 and 1.17. Any mean elasticity in this range is sufficiently close to the expected 1.0 to again support the investment nature of land.

The capital gains variables remain insignificant. Addition of three capital gains variables, CG_t, CB_{t-1}, and CG_{t-2} increases the R^2 by less than 3 percent when the yield on farm land is measured in real values.

The only obvious change in the structure of the demand for farm real estate in this earlier period is the lack of significance for the D/P coefficient. In fact, this variable possesses the correct negative sign in only one-third of the regressions and the coefficient is never statistically significant. Adding D/P as an independent variable increases the R^2 by less than one-half of one percent in all cases.

The Durbin-Watson d statistic indicates autocorrelation when GFY* is used to proxy the yield on farm real estate and in two of six cases when GFY_{t-1} is the yield variable. This autocorrelation is likely magnified due to the absence of a statistically significant negative coefficient in any of the regressions.

These results suggest that farm real estate has become, over time, more competitive with equities as an investment. This finding may be attributed to the increasing financial sophistication of farm operator-owners and to increases in nonoperator investments in farm real estate. Table 3.9 supports these conclusions in testing the log-linear form of model I from 1939-1952.

In this form, we note that, again, the competitive asset variable is insignificant while the yield on land variable always has the expected *a priori* sign and is significant at the 1 percent confidence level. T-tests reject the hypotheses that $\alpha_0 = 0$, $\alpha_1 = 1$, and $\alpha_2 = -1$, but we note that the elasticity of the price of farm real estate with respect to the yield on farm real estate (α_1) has increased over time from about 0.65 in the earlier period toward the expected value of 1.0. This change would also support a more sophisticated market for farm real estate over time.

The results for model I over the entire time period, 1939-1970, are presented in Tables 3.10-3.13. These results show the yield on farm real estate as proxied by gross farm income per acre or its expectation highly significant in explaining variations in the price of farm real estate in all regressions. Like the regressions over the latter period, 1952-1970, the land yield coefficients are in the range 3.5 to 4.5, always possess the expected positive sign, and are always significant at the 1 percent confidence level. Further, the mean yield elasticity of the price of farm real estate is within a reasonable range of 1.0, falling always between 1.15 and 1.40.

The capital gains variables, again, do not contribute any additional information. The capital gains coefficients are always insignificant and the R^2 does not change when capital gains are added to the yield on land and the yield on competitive assets as independent variables.

The competitive asset yield coefficient over the 1939-1952 period is very similar to the results reported over the 1952-1970 period. Once again the coefficient falls in the range -7.0 to -10.0 and is usually very close to -8.0. And, like the results of the latter period, the D/P coefficient is always significant at the 1 percent confidence level with a mean elasticity of about -0.40 in the full model.

Table 3.10. Ordinary least-squares regression of: $P = f(GFY_{t-1}, CG_t, CG_{t-1}, CG_{t-2}, D/P)_{1939-70}$

Equation	Constant	Independent Variables[a]			
		GFY_{t-1}	CG_t	CG_{t-1}	CG_{t-2}
3.10.1	-34.622	4.317 (17.355)**			
3.10.2	223.83				
3.10.3	-33.294	4.161 (12.038)**	0.661 (0.658)		
3.10.4	-34.604	4.272 (10.075)**	0.741 (0.717)	-0.506 (-0.455)	
3.10.5	22.197	3.714 (9.640)**	0.401 (0.464)	-0.344 (-0.372)	
3.10.6	23.169	3.645 (7.853)**	0.453 (0.504)	-0.384 (-0.404)	0.259 (0.276)

Table 3.11. Ordinary least-squares regression of: $P = f(GFY^*, CG_t, CG_{t-1}, CG_{t-2}, D/P)_{1939-70}$

Equation	Constant	Independent Variables[a]			
		GFY*	CG_t	CG_{t-1}	CG_{t-2}
3.11.1	-37.802	4.421 (19.366)**			
3.11.2	15.048	3.855 (16.008)**			
3.11.3	-36.291	4.242 (13.629)**	0.754 (0.847)		
3.11.4	-37.260	4.324 (11.398)**	0.825 (0.894)	-0.383 (-0.388)	
3.11.5	14.346	3.800 (10.893)**	0.528 (0.680)	-0.223 (-0.276)	
3.11.6	14.062	3.818 (8.954)**	0.515 (0.637)	-0.217 (-0.255)	-0.065 (-0.075)

D/P	Mean Elasticity P_L w.r.t. D/P	Mean Elasticity P w.r.t. GFY_{t-1}	R^2	Durbin-Watson d
		1.364	0.910	0.326
-29.129 (-5.640)**	-1.351		0.514	0.312
		1.314	0.911	0.346
		1.349	0.911	0.365
-8.846 (-3.691)**	-0.410	1.173	0.911	0.555
-8.883 (-3.637)**	-0.412	1.151	0.941	0.555

D/P	Mean Elasticity P w.r.t D/P	Mean Elasticity P w.r.t GFY*	R^2	Durbin-Watson d
		1.397	0.926	0.129
-8.111 (-3.811)**	-0.376	1.218	0.951	0.366
		1.341	0.928	0.113
		1.367	0.928	0.123
-7.942 (-3.610)**	-0.368	1.201	0.952	0.330
-7.928 (-3.526)**	-0.368	1.208	0.952	0.329

Table 3.12. Ordinary least-squares regression of: $P = f(GFY^*, CG^*, D/P)_{1939-70}$

Eq.	Constant	Independent Variables[a]			Mean Elasticity P w.r.t. D/P	Mean Elasticity P w.r.t. GFY*	R^2	Durbin-Watson d
		GFY*	CG*	D/P				
3.12.1	-37.427	4.386 (9.652)**	0.141 (0.090)			1.386	0.926	0.128
3.12.2	15.674	3.799 (9.302)**	0.221 (0.169)	-8.116 (-3.749)**	-0.377	1.201	0.951	0.363

Table 3.13. Ordinary least-squares regression of: $\ln P = f[\ln(Y+CG), \ln R]_{1939-70}$

Eq.	Constant	Independent Variables[a]					R^2	Durbin-Watson d
		$\ln(GFY_{t-1}+CG_t)$	$\ln(GFY_{t-1}+CG^*)$	$\ln(GFY^*+CG_t)$	$\ln(GFY^*+CG^*)$	ln D/P		
3.13.1	-0.554 (-1.425)	0.870 (10.797)**				-0.622 (-4.203)**	0.903	0.526
3.13.2	-0.525 (-1.455)		0.885 (11.826)**			-0.714 (-4.337)**	0.916 0.916	0.458 0.458
3.13.3	-0.598 (-1.453)			0.917 (11.576)**		-0.582 (-4.122)**	0.912	0.438
3.13.4	-0.570 (-1.673)				0.927 (12.675)**	-0.564 (-4.301)**	0.925	0.408

The R^2 for regressions over the 1939-1970 period are a bit lower, at about 0.945, than those of the latter years. This lower R^2 reflects the poorer R^2 over the years 1939-1952.

The Durbin-Watson d statistic indicates autocorrelated errors over the full period.

Table 3.13 indicates that the yield elasticity of the price of farm land is, like the 1952-1970 results, very close to the expected value of 1.0 falling always in the range 0.85 to 0.93. Secondly, a t-test fails to reject the hypothesis that the yield elasticity, α_1, is equal to 1.0.

The elasticity of the price of farm real estate with respect to D/P has the expected negative sign in all cases and has the correct magnitude, -0.56 to -0.71, to suggest a significant degree of land-equity substitution over the 1939-1970 period.

Finally, the constant term α_o, is not significantly different from the expected value of zero, again indicating a land-equity substitution.

To test for a change in the structure of the demand for farm real estate over the two periods, 1939-1952 and 1952-1970, a test for the constancy of regression coefficients (Chow, 1960) was conducted (see Table 3.14). This test rejected, in all cases tested, the hypothesis

Table 3.14. Chow test for constancy of regression coefficients 1939-52 and 1952-70

Equation Number			Error Sum Squrres			$F^{2k}_{n-3k}=\frac{ESS_{39-70}-ESS_{39-52}-ESS_{52-70}/2k}{ESS_{39-52}+ESS_{52-70}/n-3k}$
1939-52	1952-70	1939-70	1939-52	1953-70	1939-70	
3.6.6	3.3.6	3.10.6	283.33	585.05	4158.20	4.42**
3.7.6	3.4.6	3.11.6	175.26	175.45	3434.20	10.26**
3.9.1	3.5.1	3.13.1	0.250	0.090	0.927	6.53**
3.9.2	3.5.2	3.13.2	0.189	0.057	0.799	8.36**
3.9.3	3.5.3	3.13.3	0.218	0.060	0.828	7.67**
3.9.4	3.5.4	3.13.4	0.164	0.036	0.711	9.44**

that the regressions over 1939-1952 and the same regressions over 1952-1970 were estimates of a common relation. Table 3.14 shows the results of the Chow tests conducted on full model equations. The lowest F-statistic tabulated is 4.42 while the critical F-value for all tests in Table 3.14 is 2.53.

One possible reason for the different regression coefficients in the two periods reported is that the true relation was disturbed by the war in the earlier period. The observed residuals from the regressions in the earlier period were, in fact, quite large and negative for the war years, indicating that the price of farm land did not increase as much as expected during World War II. Several reasons for this could be advanced: the fear of another land boom followed by a market collapse similar to the experience of World War I, or a patriotic preference for government bonds as an investment.[1]

In light of these findings and in defense of the earlier results, the war years were omitted from the observations, and the model was tested again. These results are reported in Table 3.15. These results show essentially no change over earlier results which included the war years. The

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[1]The reader is referred to Murray, 1944; and Regan and Clarenbach, 1942, for a review of the farm real estate market conditions surrounding the war years.

Table 3.15. Regression results without 1942-1945 $P = f(GFY_{t-1}, D/P)$ and $\ln P = f(\ln GFY, \ln D/P)$

	1939-52		1952-70		1939-70	
Constant	6.747	2.411	-5.088	0.928	34.719	2.411
GFY_{t-1}	2.081 (9.6 **		4.609 (16.646)**		3.586 (13.606)**	
D/P	0.601 (0.273)		-9.904 (-4.325)**		-10.579)** (-4.661)**	
lnGFY		0.806 (9.362)**		1.235 (12.754)**		0.898 (20.694)**
lnD/P		-0.483 (-1.891)		-0.428 (-4.950)**		-0.640 (-8.714)**
R^2	0.940	0.935	0.970	0.962	0.943	0.972
Durbin-Watson d	0.80	1.67	1.57	1.48	1.15	1.33

land yield variable is always significant at the 1 percent confidence level, and the yield elasticity of the price of farm real estate is not significantly different from 1.0. The competitive asset coefficient is negative, as expected, and highly significant in the latter period as well as the entire 1939-1970 period, but again, the yield coefficient is insignificant for the 1939-1952 period. The elasticity of the price of farm real estate is again highly significant and possesses the expected negative sign in the latter period and over the entire period but is again insignificant in the earlier period, 1939-1952. In the latter years, 1952-1970, and over the total period, the elasticity of the price of farm land with respect to D/P is again not significantly different from -1.0 by a t-test.

In total, these results suggest that while the yield on farm real estate has always been a significant variable in the determination of farm real estate prices, the additional value, in predicting farm land prices, of the return on competitive assets has increased over time. In the post-war period, the competitive asset influence has been sufficiently strong to dominate the results of the entire period under study to show, in fact, a significant degree of competition between farm real estate and corporate equities over the period 1939-1970.

These findings support a protfolio hypothesis of the determination of the demand for farm real estate. But further, these findings suggest that the applicability of a portfolio analysis has increased over time as investors view farm real estate as an alternative to other forms of investment.

Model II

Model II was restated for testing purposes with the price of farm real estate as the dependent variable. In linear form, the reduced form is

$$P_L = \Theta_o + \Theta_1 Y + \Theta_2 \frac{\Delta P}{P} + \Theta_3 \frac{\Delta P_L}{P_L} + \Theta_4 \frac{B^S P_b}{P} + \Theta_5 \frac{M^S}{P} + \Theta_6 GFY \qquad (3.4)$$

where

Y is the GNP in constant dollars

$\frac{M^S}{P}$ is the real monetary base, because we define the private economy inclusive of the banking system;

$\frac{\Delta P}{P}$ is the GNP price deflator;

$\frac{\Delta P_L}{P_L}$ is the rate of increase in the price of farm real estate;

$\frac{B^S P_b}{P}$ is the real stock of federal government debt held in the private economy, i.e., inclusive of commercial bank and state and local government holdings but exclusive of U.S. government and Federal Reserve holdings; and

GFY is, as before, the gross farm income per acre of farm real estate.

We should, of course, have an independent variable for the real value of the stock of capital

$$\left(\frac{K^S P_k}{P}\right) .$$

This variable, however, is almost impossible to measure, but it should be highly correlated with Y. Finally, we note that when the model is stated with P_L as the dependent variable, the expected signs of the coefficients are indeterminate for all variables except θ_3 and θ_6 whose signs should be positive.

The regression results for Equation 3.4 are reported in Table 3.16. Five of the six independent variable coefficients were significantly different from zero:

$$GFY \text{ , } \frac{\Delta P_L}{P_L} \text{ , } Y \text{ , } \frac{M^S}{P} \text{ , and } \frac{B^S P_b}{P} .$$

Of these, one sign was incorrect and significant at the 5 percent confidence level

$$\left(\frac{\Delta P_L}{P_L}\right)$$

Table 3.16. Land as a proxy for capital

Eq.	Dependent Variables	Intercept	Independent Variables[a]						R^2	Durbin-Watson d
			GFY	$\frac{\Delta P}{P}$	$\frac{\Delta P_L}{P_L}$	Y	M^s/P	$\frac{B^s P_b}{P}$		
3.16.1	P_L	-41.23	0.52 (2.19)**	-0.19 (-1.53)	-0.50 (-1.84)*	0.16 (6.05)**	1.66 (3.14)*	-0.18 (-3.90)**	0.99	1.07
3.16.2	$\frac{GFY^*}{P_L}$	0.46		0.001 (1.27)	0.002 (1.04)	-0.004 (-2.22)*	-0.004 (-1.44)	0.009 (3.86)*	0.79	0.56

and one sign was definitely correct by a priori expectations and significant at the 1 percent confidence level (GFY). The other signs were, as previously noted, indeterminate. The R^2 was very high at 0.99 but the Durbin-Watson d indicated autocorrelation.

The model was then respecified with using GFY^*/P_L as the dependent variable in which case only one sign, for

$$\frac{\Delta P_L}{P_L},$$

had a definite a priori expectation. This coefficient was positive, as expected, but not significantly different from zero. This specification showed only two variables,

$$Y \text{ and } \frac{B^s P_b}{P},$$

to be significant with a much lower R^2 (0.79) and serious autocorrelation.

The results, then, were less than rewarding. The only explanation offered here for the poor performance of the model is that it was, perhaps, too heroic to expect the relations to be strong enough to make themselves evident in such a simple model.

CHAPTER IV. SUMMARY AND CONCLUSIONS

The results of this study clearly show that the demand for farm real estate has undergone a structural change since the pre-World War II years. While the demand for land has always been responsive to the yield on land, its responsiveness to the yield on competing assets appears to be confined to the post-war period. Thus we conclude that farm real estate may currently, but not previously, be viewed as a portfolio type asset which competes with other investment-type assets, namely equities, in the consumer-investors' portfolio. Clearly, as the return on equities increases, investors are induced, at the margin, out of farm real estate and into equities, causing a reduction in the demand for farm real estate, and correspondingly, a reduction in the price of farm real estate. We should expect that just as land has become more competitive with other forms of investments in the post-war period, it will become even more competitive as nonoperator investors purchase farm land. Indeed, the rise of corporate farming, through increasing the divisibility of land holdings, will make the farm real estate-equities substitution nearly perfect.

The importance of this finding for monetary purposes is to suggest, again, that the responses monetary changes are not confined to a narrowly defined group of financial assets, but rather, the return to equilibrium calls for adjustments in the markets for real assets as well. That is, the counterpart to holding fewer bonds and/or equities is not necessarily to hold more money, but rather to hold other real assets as well. This finding, of course, also suggests the applicability of portfolio analyses for the estimation of demands for other assets too.

This report does not support the use of farm real estate as a proxy for capital in general-equilibrium macroeconomic models, but neither does it subtract from the appropriateness of such a substitution. Rather, the conclusion to be reached here is a call for further research under more tightly specified econometric models and precision data. The success of such a model will likely depend upon the accuracy of specification of expectations formulation in the model.

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ACKNOWLEDGMENTS

The author wishes to express his gratitude to all members of his graduate committee for correction suggestions. To Dr. Dennis R. Starleaf, the graduate committee chairman, the author wishes to extend a sincere thanks for his valuable time spent in graduate study guidance and dissertation supervision in the author's behalf.

The author also wishes to extend a very special thanks to his wife Alice for her support and encouragement during graduate school and for her countless sacrifices to that end.

APPENDIX. SOURCES AND DESCRIPTION OF DATA

\$RY is the dollar residual yield per acre of farm real estate, computed as net income of farm operators (including inventory changes, cash wages and prerequisites furnished to hired labor, interest on farm mortgage and nonreal estate debts) minus imputed returns to farm production labor, nonreal estate capital, and operator's management. The return imputed to farm production labor was the average cash wage rate per hour times the estimated total man-hours required for production and overhead. The allowance for nonreal estate capital includes actual interest and service charges paid plus an interest allowance on equity investment in machinery, livestock, feed in store, and working capital. The allowance for operators' management represents five percent of the annual value of cash receipts and government payments. \$RY was taken from the _Agricultural Finance Review_ of January, 1972.

$\frac{B^s P_b}{P}$ is the total public debt securities (par values) held by private investors; where private investors includes individuals, state and local governments, commercial banks, mutual savings banks, insurance companies, and other corporations. This series was taken from _The Economic Report of the President_, 1972.

Y is total gross national product of the U.S. in 1958 dollars, and $\frac{\Delta P}{P}$ is the implicit price deflator for GNP. These series were also taken from The Economic Report of the President, 1972.

$\frac{M^S}{P}$ is the monetary base taken from the Data Bank Retrieval System.

D/P is the dividend to price ratio of Standard and Poor's corporate series of 500 common stocks. This series was taken from the Federal Reserve Bulletin, 1939 to 1972.

P_L and GFY were taken from Agricultural Statistics 1939-1972. P_L is the average value per acre of farm real estate, and GFY is total gross farm income inclusive of government payments, home consumption, imputed rent, and changes in inventory.