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A NEW LOOK AT THE RELATIONSHIP BETWEEN FARM REAL ESTATE PRICES AND EXPECTED RETURNS TO LAND

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Prior to the 1950's economists generally agreed the theory of rent, as primarily formulated by David Ricardo, applied to the farm real estate market. Farm real estate values could be explained and predicted by commodity prices, yields and production costs, or, more generally, net farm income. Since the 1950's, however, questions have arisen regarding the exact relationship between farm income and farmland values, and the causes of farm real estate price changes.

In the early 1970's net farm income and farm real estate prices both increased rapidly, but in the mid and late 1970's, changes in farm real estate values and net farm income did not always move in conformity with the capitalization model. These contrasting trends once again raised the question concerning the relationship between net farm income and land values, and served to remind us that our knowledge of factors influencing farm real estate values is still imperfect.

Past research has been largely time-series analysis in which, typically, a single equation linear regression model is developed and estimated. A number of lags have been used to express the functional relationship between certain variables, most notably farm income and farm real estate prices. Effects of technological change, farm support programs, urban pressures, and capital gains, among other factors, have been examined.

The model developed in this study differs from past research in three ways. First, it utilizes the basic capitalization approach alone to explain farmland price changes through time. Second, it develops a net income series which is designed to more accurately portray the residual return to farm real

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estate. Third, it employs a polynomial distributed lag model to explain the impact of net returns on farm real estate prices.

DEVELOPMENT OF MODEL

Implicit in the development of this model is the assumption that the supply function for farm real estate is inelastic, and that a single equation model is appropriate to farmland price studies. This assumption is supported by at least one study (7) which utilized a simultaneous equation system and failed to provide evidence that the supply of farmland is, in fact, responsive to price.

It is hypothesized that the value of farmland is ultimately determined by the income that can be generated through its use in agricultural production. Melichar (11) has pointed out that net farm income as estimated by the USDA represents the residual return to unpaid capital, labor, and management employed in the farm sector. Through time, as capital has been substituted for labor, the share of this aggregate earned by capital has increased while the share earned by labor has declined. By subtracting the amount earned by labor and management from the aggregate net return to all unpaid resources, Melichar obtains the residual earnings of farm production assets.[1/] Melichar shows that this residual is more closely related to the rise in the value of production assets than is the broader net farm income measure. This finding suggests that if we could measure the earnings of real estate better, we might improve our understanding of farm real estate values.

[1/] Calculated by Melichar as operator's net farm income plus net rent and interest on debt, minus charges for management and operator's labor.

Moreover, Boxley and Walker (1), referring to an earlier study by Walker, report that rent and land values in 13 North Central states have tended to move together over a 59-year period. Considering Melichar's and their own results, Boxley and Walker conclude: "The two studies suggest that land prices do follow land returns, which denies the existence of an income paradox."

With support from these two studies, we hypothesized that the capitalization model, with appropriate lags, would explain land price changes if a series measuring the per acre net return to real estate could be developed.

Assuming non-real estate assets earn a rate of return equal to the average interest rate charged on outstanding non-real estate farm debt, the residual return to real estate was calculated from Melichar's return to production assets by the following formula:

$$\text{Return to Farm Real Estate} = \text{Return to Production Assets} - \left[\text{Interest on Non-Real Estate Farm Debt} \times \text{Non-Real Estate Production Assets}\right]$$

This return was then divided by land in farms to obtain the appropriate per acre net return to real estate.

While capitalization theory dictates that the value of an acre of land is the future net income expected from it discounted to the present utilizing some appropriate discount rate, a major problem is the determination of expected net income in an industry characterized by widely fluctuating production, and prices as volatile as commodity prices are in agriculture. We hypothesized that farm operators look several years into the past in formulations of expectations of income. That is, net return to real estate has a distributed lag relationship with the value of farmland.

A commonly used distributed lag in expectation models is the geometric lag. In this distribution, the effect of the independent variable on the dependent variable extends indefinitely into the past, decreasing geometrically. This model, as well as others patterned after it which appear in farm real estate literature (2,7 for example), has a major drawback in that the effects of net income, i.e., the coefficients of expectation, are restricted to following a specific pattern.

To minimize this problem, we employ a different distributed lag model - the polynomial lag, often referred to as the Almon (5) lag. In the Almon lag, the weights for past time periods are assumed to follow a polynomial of some appropriate degree. By assuming the weights, or coefficients of expectation, lie on a polynomial, the number of parameters is reduced from $n + 1$ ($W_0, W_1, \ldots W_n$) to one more than the polynomial degree ($p + 1$). The new parameters ($p + 1$) can be estimated by ordinary least squares and then transformed into the original weights. If the polynomial lag model satisfies the assumptions of the classical linear regression model, then the estimates are unbiased, consistent, and efficient, and lead to valid tests of hypotheses concerning the weights (10, p. 493). It is anticipated that by increasing understanding of the functional relationship between farmland values and net returns to real estate, the impact income has on farm real estate prices can be more accurately ascertained.

Our model is completed by the addition of an appropriate capitalization rate and can be represented by the following linear regression equation:

$$V_t = b_1\, NRETURN + b_2\, CAPRATE + U_t$$

Where:

V_t = *the average value of farm real estate per acre in time period t.*

NRETURN = *a weighted sum of the residual net earnings of real estate per acre realized during the current time period and n-time periods before time period t.*

That is:

NRETURN = (W_0 *NRETURN*$_t$ + W_1 *NRETURN*$_{t-1}$ + . . . W_n *NRETURN*$_{t-n}$) *where the coefficients of expectation, the "W" terms, follow a polynomial of some degree.*

CAPRATE = a capitalization rate, lagged one year.[2/]

u_t = *a random disturbance term in period t.*

All observations are expressed in real terms (1967 = 100) based upon the gross domestic product implicit price deflator.

STATISTICAL CONSIDERATIONS

To estimate our model, it is necessary to specify three parameters: the appropriate polynomial degree upon which the weights lie, the lag length, and whether or not any endpoint constraints should be imposed. In a previous paper (6), we hypothesized that past net income has progressively less influence on current real estate prices reaching zero at some point. Since no turning points were expected, we hypothesized the influence could be captured by the declining segment of a 2nd degree polynomial. Good results were obtained with the 2nd degree polynomial and an arbitrary lag length of 5 years.

Additional research has shown, however, that more careful attention must be paid to the specification of the polynomial model. Schmidt and Waud (12), among others, have demonstrated that chosing incorrect parameters may constitute specification error.

[2/] The average interest rate on non-real estate farm debt was used as a proxy for the capitalization rate. This rate was chosen because it was felt that it more accurately reflects changes in current market rates and alternative returns in the farm sector than would the average rate on outstanding farm real estate debt. The latter rate changes slowly because it contains rates on loans made over a number of years, and it substantially lags interest levels at any particular time.

More specifically, selecting an incorrect lag length, smaller than correct polynomial degree, or improper endpoint constraints will result in model misspecification, and, therefore, would lead to biased and inconsistent estimates and invalid statistical tests. If a larger than correct polynomial degree is inserted in an otherwise correct model, misspecification does not result. Rather, irrelevant variables are added which can, it has been suggested, be detected with standard statistical tests.

In the absence of valid standard tests, a number of methods for specifying the polynomial model have been proposed. Schmidt and Waud suggest in the absence of a priori knowledge, the researcher discriminate between different values of polynomial degree and lag length using some criteria such as minimum standard error (MSE) or Theil's $\overline{R}^2$. And, unless a priori knowledge indicates endpoint constraints exist, none should be imposed.

Hicks (8) states that if multicollinearity is present, the standard errors of the coefficient estimates rise, and thus, use of the t-statistic to detect irrelevant Almon variables from too large a polynomial degree may, in fact, lead to the omission of relevant explanatory variables. However, Hicks suggests that since the distribution of the residual sum of squares is not affected by multicollinearity, one can test for the polynomial degree by employing a test based upon an F statistic which tests for significance of added explanatory power from adding Almon variables. Hicks proposes using this procedure with an arbitrary lag length and then using MSE or $\overline{R}^2$ to choose lengths within the chosen polynomial degree.

Harper (4) noted that researchers using MSE or $\overline{R}^2$ criterion in the selection of models using identical data came to contradictory conclusions in the monetary versus fiscal policy debate. Examining the properties of the estimators when an incorrect lag length and/or smaller than correct degree of polynomial, Harper shows that under these conditions the disturbances are still normally distributed with a constant variance, but have a non-zero expected value. Harper notes that two specification error tests, termed Reset and Raset, have been developed by Ramsey which test for non-zero mean, and, therefore, can be used to detect specification errors resulting from an incorrect lag length and/or smaller than correct polynomial degree.[4/] The two tests do rely on different sets of assumptions, and hence, can have different degrees of power in detecting errors in any particular model. Thus, an appropriate criterion would be to reject any model which fails either of the tests.

In this study we examined 2nd, 3rd, and 4th degree polynomials with lags ranging from 4-10 years, 5-10 years, and 6-10 years in the 2nd, 3rd, and 4th degree specifications, respectively. We had no a priori knowledge which would suggest constraining either the head or tail endpoints; hence, none were imposed. The equations were estimated with both ordinary least squares and autoregressive least squares using the Cochrane-Orcutt iterative procedure. We applied all possible criteria discussed above in an attempt to find a model(s) which could not be rejected by any criterion.

Using the F-test suggested by Hicks on all lag lengths, we found no significant explanatory power resulted from increasing the polynomial degree. Using the minimum standard error and $\bar{R}^2$ criterion suggested by Schmidt and Waud proved the 2nd degree, 8 year lag model to be superior. And, only two models could not be rejected by applying the Ramsey specification tests proposed by Harper - the 2nd degree, 8 year and 2nd degree, 7 year models.

[4/] One should note that although these tests can be shown in theory to be detect specification errors, the power of the tests against any particular error could vary. Additionally, these tests could reject a model for reasons other than misspecified degree or lag such as omitted relevant variables. Whatever the reason for rejection, however, the researcher should be aware of any bias in the estimation.

Thus, of the 18 alternative models examined, only the 2nd degree, 8 year lag model could not be rejected by any of the decision criterion.

EMPIRICAL RESULTS

The results of the autoregressive least squares estimation of the 2nd degree, 8 year model are presented in Table 1.

TABLE 1. EMPIRICAL RESULTS, U.S. FARM REAL ESTATE PRICES, 1950-1977

Independent Variable	Coefficient	Standard Error	t-Statistic
NRETURN	13.364	2.766	4.832
CAPRATE	-12.101	3.148	3.844
DISTRIBUTED LAG COEFFICIENTS			
$W_0(t)$	.401	.310	1.294
$W_1(t-1)$	1.721	.269	6.398
$W_2(t-2)$	2.562	.299	8.569
$W_3(t-3)$	2.924	.328	8.915
$W_4(t-4)$	2.808	.354	7.932
$\hat{W}_5(t-5)$	2.214	.426	5.197
$W_6(t-6)$	1.142	.595	1.919
$W_7(t-7)$	-.408	.872	-.548
Mean Lag	3.136	.977	3.210

$\bar{R}^2$	F	SSE	D.W.	S.E.
.987	402.75	248.77	2.80	4.375

Net returns is positive as expected and statistically significant at the 95% confidence level. The capitalization rate is negative as expected and also significant.

However, the influence of past returns does not have the specific influence expected; that is, progressively less importance is not placed on returns each year in the past. Rather, the coefficients of expectation increase for a time, peaking in *t-3* and then declining until the influence in *t-6* is not statistically significant. From the model, then, we can see that the greatest impact on real estate prices is generated by returns in the previous 2-5 years. From this, we can see that even if anticipated market conditions in the upcoming year appear less than favorable but some previous years were good ones, farm operators may still be willing to pay high prices for land.

CONCLUSIONS

The major conclusion of this study is that the capitalization model explains variations in the real level of farm real estate values in the U.S. during the past 27 years. In finding support for the capitalization approach, this study incorporated two features which earlier studies may have overlooked.

First, this study drew on the work of Melichar and estimated the net return to farm real estate rather than using an aggregate measure of net farm income. Net farm income used in earlier studies contained the return to labor, management, and non-real estate capital, as well as that earned by real estate.

Second, the study shows that the way farmland buyers form expectations regarding net returns to real estate is important. This study found that expectations regarding income are based, for the most part, on returns earned the previous 2-5 years. And, given the pattern of the lag relationship, we can expect upward pressures of a high income year such as 1973 will continue through 1979 with the largest impact felt in 1975, 1976, and 1977.