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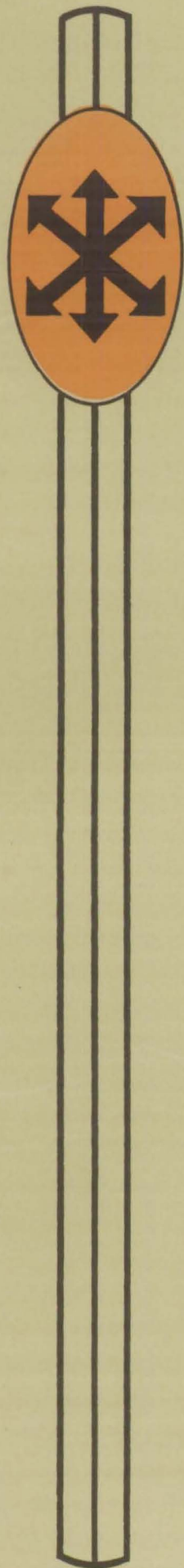
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THE MYSTERY OF INFLATION AND REAL FARMLAND VALUES

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The Mystery of Inflation and Real Farmland Values

Declining agricultural land values are the most pervasive evidence provided in the popular press to demonstrate the extent of the current farm crisis. Economists have long been involved in studying factors which determine land values on a theoretical basis. The rapid rise in agricultural land values in the 1970's and the subsequent drop in the 1980's have stimulated a number of empirically based land studies. Much of this work has focused on the relationship between returns from farming and land values.

In general, past research on agricultural land values can be categorized using three measures: (1) farm based returns, either explicitly or via a hedonic approach utilizing parcel characteristics, (2) discounted capital gains associated with agricultural land values, and (3) more comprehensive capital asset pricing models.

Phipps concluded that there was a significant unidirectional causal flow from current farm returns to farmland values. Burt found modern time series methods (autoregressive moving average techniques) tracked farmland prices quite well from 1960 to 1983. His model included current and lagged farm rental rates as independent variables.

Melichar showed that real capital gains from farmland had compensated farmers for slow growth in current returns on land during much of the 1970's. He further explained that an indirect relationship between capital gains and current returns is expected if farmland owners are to earn a return on assets comparable to

opportunity costs. Castle and Hoch apportioned changes in farmland prices into three components: earnings (or current returns), real capital gains, and inflation. They found that farmland price appreciation through 1978 could not be explained fully by increases in the current returns from farming.

Capital asset pricing theory has provided several advantages in estimating agricultural land values. The incorporation of agricultural rents, growths in rents, interest rates and inflation used to form a theoretically sound and empirically testable model. Espel and Robison used a general capitalization formula to examine land prices in market equilibrium. Barry utilized a capitalized asset pricing model to estimate risk premiums for farmland investment.

Extensions of the capitalization model have explored the effects of inflation on land values. Feldstein used a simple portfolio model with three assets -- land, bonds, and common stock -- to show conceptually that inflation leads to increases in the demand for land and, thus, an appreciation in real land prices as investors search for an effective hedge from inflation.

Two recent econometric studies have investigated the influence of inflation on land values. Robison, Lins, and Venkataraman regressed inflation, along with other variables, on nominal land values for twenty-four states and generally found that inflation significantly affects nominal land values. Alston found that inflation had a small negative impact on real farmland values in his analysis of data from eight Midwestern states. However, his analysis only concentrated upon

the impacts of inflation on interest rates (and their corresponding influence on real land values), rather than using a more encompassing impact of land as an inflation hedge.

Randall and Castle went further and theoretically examined the influence of anticipated and unanticipated changes in inflation on real land values. Their conclusion was that correctly anticipated inflation had no affect on real land values. That is, if the market correctly predicts future inflation, there will be a commensurate adjustment in nominal land values to reflect such changes in the general price level. However real land values will remain unchanged. Alternately, unanticipated inflation (i.e., actual inflation that was not correctly anticipated by the land market) will cause a one-time increase (decrease) in real land values.

Similar to Randall and Castle is the concept of expected and unexpected inflation on agricultural land values. Considerably more work has been done on the effect of unexpected (or, uncertain) inflation on other assets, most notably stocks (Olsen, Hasbrouck, and Fogler).

A theoretical piece by Chen examined the effects of uncertain inflation on risky assets using capital budgeting. He found that uncertain inflation affects the risk-adjusted discount rate, the certainty equivalent factors, and the market value of a risky asset as the investor re-evaluates risk expectations due to changes in the unanticipated rate of inflation.

Fama and Schwert compared the returns from various assets (treasury bills, government bonds, real estate, labor income and

common stock returns) as effective hedges against expected and unexpected inflation. Although the return to private residential real estate was found to be a complete hedge against both types of inflation, the use of the Home Purchase Price component of the CPI as a return to real estate, as well as an insufficient time horizon, is suspect if the intent is to evaluate the performance of agricultural land.

The purpose of this paper is to augment the capitalization model with clearly defined components of expected and unexpected inflation. Actual land transaction data combined with parcel specific characteristics are used to explain changes in farmland values in selected counties of Kentucky from 1977 to 1985. The model explains real farmland values on the basis of current and expected future returns, and expected and unexpected increases in land values due to inflation.

CONCEPTUAL FRAMEWORK

The capital asset pricing model for land represents the price of farmland as the present value of the infinite stream of rents accruing from the land:

$$(1) V_0 = \int_0^{\infty} e^{-rt} [R(t)] dt$$

where V_0 is the value of a unit of land at time 0

r is the real discount rate

t is time

$R(t)$ is land rent per unit at time t .

Thus, the market value of land as a productive asset is represented by the anticipated stream of rents accruing at all subsequent times and the return from alternative investment opportunities which are reflected in the discount rate.¹

If land rents are assumed to grow at a constant real rate, g , indefinitely, equation (1) becomes:

$$(2) \quad V_0 = \int_0^{\infty} e^{-rt} [e^{gt} R(t)] dt = \int_0^{\infty} e^{(g-r)t} [R(t)] dt$$

where g is the constant real rental growth rate.

At the end of period for any time t , equation (2) becomes:

$$(3) \quad V_t = \frac{1 + g_t}{(r_t - g_t)} R_t.$$

Note that in an uncertain world, the expected value of r and g determine land values at any given time. Hence, one can think of r and g as the expected discount rate and the expected growth in land rents, respectively.

As noted earlier, expected rates of inflation that are correctly anticipated on an ex post basis have no effect on real land values and only are reflected in nominal land values. However, inflation can affect real land values in two ways. The first is when land market participants change their expectations of the future course of inflation. This is termed the expected inflation effect. It is important to realize that this does not refer to the idea of correctly anticipated inflation as discussed above. Here we are referring to

intertemporal changes in expected rates of inflation by the land market. If the inflation rate increases, people are likely to adjust their demand for land because their expectation of future inflation is higher than before. This is based upon the premise that land is viewed as an inflation hedge (Feldstein). A second way that inflation could affect real land values is through one-time changes in values brought about by actual inflation, as determined on an ex post basis, differing from what was expected on an ex ante basis (what is termed unexpected inflation in preceding discussions).

Incorporation of these two effects, the expected inflation effect and the unexpected inflation effect, requires the addition of two terms to equation (3) which results in:

$$(4) \quad V_t = \frac{(1 + g_t^*)}{(r_t^* - g_t^*)} R_t + f(i_t^*) + h(i_t - i_t^*)$$

where i_t is the actual inflation rate in time t ; the asterisk denotes an expected value.

The function f measures the effect of expected inflation on real land values and h measures the effect of differences between actual and expected inflation on real land values. It is hypothesized that land values will increase as both $f(i^*)$ and $h(i - i^*)$ increase.

MODEL SPECIFICATION

The empirical model from equation (4) is similar to the one used by Vantreese et. al. A general rent function was specified which

includes parcel characteristics:

$$(5) \quad R_i = a_0 + a_1 \frac{1}{D_i} + a_2 S_i + a_3 S_i^2 + a_4 C_i + a_5 P_i + a_6 T_i$$

where R_i is the rent associated with parcel i

D_i is the distance of the i^{th} parcel to the county seat

S_i is the size (in acres) of the i^{th} parcel

C_i is the percentage of cropland of the i^{th} parcel

P_i is the percentage of pasture of the i^{th} parcel and

T_i is the tobacco quota for the i^{th} parcel.

Note that the coefficients on the rent function are invariant with time, so the time subscript (t) is dropped.

If the capitalization coefficient, K_{it} , is defined as follows:

$$(6) \quad K_{it} = \frac{(1 + g_{it}^*)}{(r_t^* - g_{it}^*)}$$

and f and g are linear functions of their arguments, then

$$(7) \quad V_{it} = a_0 K_{it} + a_1 \frac{K_{it}}{D_i} + a_2 K_{it} S_i + a_3 K_{it} S_i^2 + a_4 K_{it} C_i + a_5 K_{it} P_i + a_6 K_{it} T_i + b_1 i_t^* + b_2 (i_t - i_t^*) .$$

Note that the a 's in equation (7), having been multiplied by the capitalization coefficient, are equal to the rental values associated with each parcel-specific characteristic (equation (5)). The b 's reflect land value effects since their corresponding variables do not enter formally into the capitalization model.

Estimation of equation (7) requires measurement of expectations for both the capitalization components and an inflation variable. Expectations for this study are developed from a weighted average of lagged values. The expected rate of inflation is determined using the following formulation:

$$(8) \quad i_t^* = \frac{\sum_{n=0}^4 (5-n) (i_{t-n})}{\sum_{n=0}^4 (5-n)}$$

Expected rates of inflation are assumed to be formulated by examining inflation rates for the past five years with more recent years weighted heavier, which is consistent with adaptive expectations.

Similarly, expected rates of interest are estimated using equation (8). Interest rates over the past five years are thought to affect the expected rate of interest with more recent years having a greater impact on expectations.

Expected growth in agricultural land rents is determined in a similar manner with the addition of a smoothing technique to dampen the extreme volatility in agricultural rents since 1960. The expectations model for rents presumes that although rents are highly variable from one year to the next, expectations about future growth in rents are formed by discounting large deviations from some underlying long-run growth rate, \bar{g} . The further a particular year's growth rate deviates from \bar{g} , the less influential it is thought to be in determining expected growth rates. In addition, more recent

observations are weighted heavier (*ceteris paribus*) than more distant observations. Finally, because of the extreme volatility in land rents, the time span of the expectations function was extended to ten years. A formulation which is consistent with this expectation function is:

$$(9) \quad g_t^* = \frac{\sum_{n=0}^9 W_{t-n} g_{t-n}}{\sum_{n=0}^9 W_{t-n}} ; \quad W_{t-n} = \frac{(10-n)}{(g_{t-n} - \bar{g})}$$

Expected growth in rents are calculated for crop and pasture land. The expected growth in rents for a particular parcel are obtained by weighting g_t^* with the proportion of cropland and pasture of that parcel:

$$(10) \quad g_{it}^* = g_{ct}^* C_i + g_{pt}^* P_i$$

where g_{ct}^* and g_{pt}^* are expected real growth rates for cropland and pasture, respectively, as estimated from equation (9), and C_i and P_i are the percentages of cropland and pasture for the i^{th} parcel. This allows the expected growth rate for all non-crop/non-pasture land to grow at a real rate of zero, i.e., to maintain a nominal growth rate equal to the rate of inflation. The use of crop and pasture rents is thought to be superior to the use of cash rents since the latter refers to the rent associated with the entire farm, buildings etc.

Real interest rates and growth rates are obtained by subtracting the expected rate of inflation from their respective expected nominal rates. Thus, all components of the capitalization formula are measured in real terms.

DATA

The data for the analysis came from individual agricultural land transactions for twenty-nine counties in Kentucky. These counties represent the diversity of agricultural production in Kentucky -- the cash grain areas in the western part, the cow-calf areas in the central part, and the burley tobacco belt throughout the state. The time period covered 1978 to 1985 and included 2,109 observations. All transactions involving parcels of less than 10 acres and/or less than two miles from the county seat were deleted to reduce possible biases from urbanization. Because the study involved time series observations, all land values were adjusted to 1985 dollars using the G.N.P. implicit price deflator.

Parcel-specific data for the study were collected from the Federal Land Bank (FLB) in each of the counties, except the base quota for tobacco at the time of sale, which was gathered from the Agricultural Stabilization Conservation Service. Distance to the market was measured as distance from the parcel to the county seat, where most purchases of inputs and marketing of commodities were thought to occur and where urbanization pressures are highest. Bare land values per acre were based on actual land market transactions, after excluding the value of any buildings as appraised by the FLB

agent in that county.

State-wide average cropland and pasture rents for Kentucky (used to calculate expected rental growth rates) were obtained from the Statistical Reporting Service (U.S.D.A.). The underlying long-run growth rates, \bar{g} , for cropland and pasture rents were calculated as a simple average of the past seventeen years (the full extent of the available data).

Expected discount rates were estimated from the rate of return on Baa corporate bonds, which were chosen to incorporate the return associated with an investment with a risk similar to the purchase of agricultural land.² Expected inflation rates were estimated using the G.N.P. implicit price deflator (U.S. Department of Commerce).

RESULTS

Basic results are presented in table 1.³ The effects of the tobacco quota were allowed to vary by county and by year. Further, no tobacco variables were multiplied by the capitalization coefficient because to do so assumes that quota holders believe there is an infinite time horizon for the tobacco program -- a heroic assumption.

Since all rental variables, except the tobacco quota, were multiplied by K_{it} , the coefficient measures the effects of the variables on the rent function. The third column of table 1 translates these rental coefficients into land values using the mean value of K_{it} (19.19). Coefficients for all variables are of the expected sign and all are significantly different from zero at the one percent level -- except the tobacco quota variable. Table 1 only

presents the average value of a pound of tobacco quota for 1985. That particular coefficient is not significantly different from zero at the one percent level, but most other tobacco coefficients were significantly different from zero.

Because the distance relationship is specified as non-linear, the partial derivative and the elasticity of distance on land values depend on distance. For example, rental values five miles from the county seat are \$ 16.52 lower per acre than rents for land two miles from the county seat, or land values are \$ 317 lower per acre. The effect of distance on land rents and values diminishes as distance increases.

The results of the quadratic size effect show that there is a convex relationship between size and land values, thus small and large parcels tend to be worth more per acre than medium-sized parcels. The relationship reaches a minimum at 1455 acres, which is quite large by Kentucky standards (the mean parcel size was 93 acres). This relationship is obviously caused by the preponderance of small hobby farms which are common in throughout the state.

A one percentage point increase in cropland and pasture land, respectively, increases rents \$ 47.71 and \$ 21.88 per acre above other land (which would include forest land, wetlands, and land surrounding the homestead and buildings). The average farm size in the study was 93.36 acres, so a one percentage point change would translate into .93 acres. Thus, the results imply that cropland and pasture land rent for \$ 51.30 and \$ 23.53 per acre, respectively, above non-crop, non-

pasture land, or, using the average capitalization coefficient, sell for \$ 984 and \$ 452 per acre above other land.

The magnitude of the coefficient for the tobacco quota (\$ 4.01) is quite plausible. Cash lease rates for tobacco in 1985 were approximately 40 - 60 cents per pound and many observers believe the tobacco program will change substantially in 5 to 10 years. The present value of a 50 cent per year return from a tobacco quota for ten years with a 4 percent real rate of interest results is \$ 4.06 (assuming that lease rates are constant over the ten years in real terms). Thus, the \$ 4.01 value for a tobacco quota in 1985 is reasonable.

Changes in expected inflation were found to have a pronounced impact on real farmland prices (note that the variables for expected and unexpected inflation were not multiplied by K_{it} therefore their coefficients measure land value impacts). A one percentage point increase in the expected inflation rate increased real land values \$70.04 per acre, or 6.0 percent of the mean land value per acre. This is a very large positive direct effect, but one must remember that the expected inflation variable is smoothed so that it is much less variable than annual inflation rates.⁴

Unexpected inflation was also found to have a significant, positive impact on land values. The effect of unexpected inflation was slightly larger than the effect of expected inflation, though expected inflation varied more on an absolute basis than unexpected inflation did (again, see footnote 4). A one percentage point difference between actual and expected inflation increases land prices

by \$ 78.12, or 6.7 percent of the mean land price in the sample.

Note that the positive direct impact of expected inflation on real land values is very close to the indirect negative impact of expected inflation in the unexpected inflation term. This indicates that the land market pays much closer attention to actual inflation than expected rates of inflation formed during the prior time period in determining the real price of farmland. That is, expectations of future rates of inflation are very important in determining real land values on an ex ante basis. However, on an ex post basis, expected rates of inflation are unimportant because people have already observed actual rates of inflation for that time period.

In fact, the negative indirect impact of expected inflation is larger than the positive direct impact. This result is consistent with Alston's -- changes in inflation expectations have a small negative impact on real land prices. In addition, this analysis found that actual inflation has a strong positive impact on real land prices.

CONCLUDING COMMENTS

This paper used a capitalization model augmented with inflationary effects to study the factors influencing real land values in Kentucky on a parcel-specific basis. The results of the model demonstrate that a simple capitalization model can be used to not only embody parcel characteristics into a land price equation, but also to explain the general path of real land values. The results lend support to the inclusion of both expected and unexpected rates of

inflation in land market models and to numerous claims that a recurrence of high inflation rates could substantially increase real land values.

The next step in exploring the impacts of inflation on land values is to incorporate inflation, risk and taxes more formally into the capitalization formula. The 1981 tax reform certainly had an impact on farmland values. Further, a rational expectations approach in determining expected interest rates, inflation, and growth in rents could be fruitful. Such a technique might capture the apparent learning process the financial markets have gone through in recent years as the Federal Reserve Board has succeeded in controlling inflation.

FOOTNOTES

¹Income, capital gain and property taxes are not included in this and subsequent models due to problems of specifying tax rates for individual farmers.

²Baa corporate bonds are "considered as medium grade obligations, i.e., they are neither highly protected nor poorly secured. Interest payments and principal security appear adequate for the present but certain protective elements may be lacking or may be characteristically unreliable over any great length of time. Such bonds lack outstanding investment characteristics and in fact have speculative characteristics as well."(Moody's, p. 1)

³In order to control for county effects, dummy variables were added so that the intercept could vary by county (though the results by county are not reported here).

⁴Actual and expected inflation rates are provided to illustrate how they have changed over time:

	1977	1978	1979	1980	1981	1982	1983	1984	1985
i	5.9%	7.4%	8.6%	9.2%	9.4%	6.0%	4.2%	3.6%	3.2%
i*	7.0%	7.0%	7.3%	8.0%	8.7%	8.0%	6.7%	5.4%	4.3%

Table 1. Results of the Regression to Explain Real Land Values

Variable	Rent Coefficient	Capitalized Value
K_{it}	-33.92 (-4.83) ^a	--
D_i	55.07 (9.72)	1057
S_i	-0.032 (-4.89)	-0.61
S_i^2	0.000011 (4.91)	.00022
C_i	47.71 (15.79)	916
P_i	21.88 (8.61)	420
T_i		4.01 (1.26) ^b
i^*		7,004 (3.86)
$i - i^*$		7,812 (5.19)

^aT-values are in parentheses

^bThe regression results yielded only capitalized values for tobacco and inflation factors.

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