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US Land Prices: Trends and Determinants

INTRODUCTION

Previous research

Determination of farmland prices was a topic of broad interest in the United States following the explosion of both land and commodity prices in the 1970s, followed by the rapid decline of land prices and the accompanying farm debt crisis in the early 1980s. These wide swings in farmland prices followed 50 years of more gradual adjustments. Institutionally, some adjustments have taken place in the 1970s and 1980s. Cropland acreage fluctuated, the proportion of farmland purchased by nonfarmers increased in the 1970s and the sources of farm real estate debt financing shifted. But similar changes also occurred in earlier periods.

Many competing arguments have been advanced to explain the large magnitude of US land price movements. However, the wide variety of explanations in the literature suggests that little agreement has been attained in the agricultural economics profession. In an analysis of land prices presented at the 1979 AAEA Annual Meetings, Reinsel and Reinsel (1979) argued that loose credit allowed land prices to rise rapidly in the 1970s. Melichar (1979) countered with arguments that consideration of capital gains in addition to increased returns to farming fuelled the rapid price boom. In further discussion the following year, Feldstein (1980) used a portfolio choice model to show that rapid inflation, such as occurred in the 1970s, can cause a land price increase that is particularly large in real terms because of a related decline in corporate equity.

These discussions inspired a host of more empirical land price studies, many appearing in the *American Journal of Agricultural Economics*. Phipps (1984) obtained empirical results from which he concluded that non-farm impacts on farmland prices were minor. In contrast, Robison, Lins, and VenKataraman (1985) found that nonfarmland demand and inflation were important. In further contrast, Alston and Burt (1986) found that inflation was not important but that rental rates were.

On another point of controversy, Shalit and Schmitz (1982) found that credit market constraints caused both a rapid price expansion when the collateral value of assets was increasing and vice versa. These findings are in sharp contrast with

the arguments and results of Reinsel and Reinsel who argued that loose credit was behind the boom in land prices.

As these examples indicate, many of the explanations of land price movements have been both supported and rejected by alternative empirical studies. As in other areas of study, the contractions can be traced to a difference in assumptions and specifications. For example, many empirical studies use a relatively unstructured econometric approach in which spurious correlations with inappropriate variables or natural correlations with omitted variables can cause results to vary widely depending on model specification.

Other studies that have attempted to use more highly structured or theoretically based models have suffered from a need to adopt strong assumptions which have limited their acceptance. Furthermore, even these more structured models do not contain sufficient structure to analyse all of the broad range of factors affecting farmland prices.

With this high level of conflict, it is very difficult for a paper such as this to draw a consensus from the literature. So, instead, we will present some empirical results in which we have attempted to let conceptual analysis of the data identify the relative importance of these various explanations. The empirical results are based on a model of land prices that was developed at the University of Maryland by the first author under a co-operative agreement with the Economic Research Service.

The model of farmland prices is sufficiently structured to permit theoretically defensible analysis of a broad range of issues including joint consideration of the effect of returns to both ownership (capital gains) and operation, the effect of inflation and interest rates on debt and savings, the effect of credit market constraints, the effect of agricultural and tax policies, and the effect of alternative expectation schemes.

Considerations in modelling land markets

Before proceeding to the model specification and the results, a few words about the modelling philosophy are appropriate. The traditional *ad hoc* approach to empirical analysis has the advantage of imposing few *a priori* assumptions but is vulnerable to finding misleading results because of spurious correlations and an inability to identify proper functional forms. It also tends to identify the role of only a few factors, so information on interaction of those factors with others (that may be subject to large changes in the future) is not obtained. Theoretical analysis, on the other hand, suffers from the intractability of incorporating a broad range of variables into the analysis without stringent assumptions. In this study, we attempt to draw on the advantages of both approaches. The model is specified with as much structure as fairly general assumptions will allow so as to attain theoretically plausible results and the econometric efficiency that *a priori* imposition of the theory will allow. Once this is done, the model contains several unknown parameters for which relatively good extraneous information exists – so that the parameters can be identified more accurately from the extraneous information than econometric estimation is likely to allow. Upon

imposing this extraneous information, the remaining parameters are estimated with conventional methods.

A few examples can illustrate these considerations that are incorporated into the model structure. First, the driving force in land markets in addition to the discounted value of returns to farming is assumed to be wealth accumulation. Wealth on a cash-out basis is represented by the acreage of land held times the real price of land plus real savings less real debt, transactions costs on selling land, and taxes incurred on sales. This relationship points to several important effects that can drive land prices and, more importantly from the standpoint of modelling, indicates the relative effects of those variables; that is, savings, debt and land transactions costs and taxes are equally weighted in determining wealth.

Second, consider the effects of inflation. Inflation has separate and distinct effects on each of the components of wealth. First consider the debt-reducing effects of inflation. A farmer can expect a rapid rate of real debt retirement with high inflation even with relatively small payments on principle. Conversely, this debt-reducing 'value' of holding land is lost in a period of low inflation. An adequate model of land prices must reflect the way in which inflation affects this return to holding land in addition to the conventional value of land reflected by the discounted value of future returns.

Third, consider the effect of inflation on alternative investments. High inflation tends to erode savings which by comparison makes holding land relatively more attractive. Alternatively, in periods of low inflation, holding savings becomes relatively more attractive. An adequate model of land prices must reflect both the savings-erosion and debt-reducing effect of inflation in order to properly capture the effect of inflation on land prices. Furthermore, to the extent that wealth is a driving force behind land markets, these two inflation effects carry equal weight.

Finally, consider the effects of tax law on the value of holding land and how those effects interact with the rate of inflation. Suppose that only 40 per cent of capital gains are taxable, as they have been in the US until 1987. Then, when land prices are appreciating, holding land is a particularly attractive way to accumulate wealth because it receives a 60 per cent tax break. For example, for an individual in a 25 per cent tax bracket, a rate of return on savings of 10 per cent and a rate of appreciation in land prices of 8.25 per cent both produce an after tax return of 7.5 per cent. This suggests an important effect of the change in tax law on behaviour of land prices in an inflationary land market whereas the effect on land price behaviour in a flat land market will be unaffected. This illustrates how consideration of structure can be brought to bear on modelling land prices. The typical *ad hoc* approach in estimating land price models does not take these considerations into account and thus cannot use estimates from inflationary periods to analyse or project land prices in deflationary periods or to estimate the effects of eliminating the capital gains tax break.

Another important element of model structure follows from credit market imperfections. Traditionally, agricultural lenders have granted credit only up to a maximum ratio of debt to assets. Some farmers find this constraint binding while others do not. Thus more than one regime of behaviour may explain the behaviour of individual farmers. The relative share of farmers in each regime can be crucial in determining how land prices behave. In an inflationary market, the

debt constraint tends to relax because appreciated values of earlier acquisitions provide the collateral for further borrowing. On the other hand, as expectations of future land prices rise, increased land transactions can cause the debt constraint to tighten. The opposite effects occur in a deflationary market.

A MODEL OF LAND PRICES

To facilitate the production of a theoretically defensible structure as opposed to *ad hoc* specification, several assumptions are employed in this paper. These assumptions may be regarded as quite restrictive compared to most *ad hoc* empirical analyses but less restrictive than most theoretical analyses. The major assumptions are that: (1) the utility level of farmers depends on consumption and wealth (evaluated on a cash-out basis), is strongly separable in consumption and wealth, and follows constant absolute risk aversion in both; (2) production follows constant returns to scale; (3) capital markets are imperfect in that the savings interest rate is less than for borrowing, finance charges are incurred in obtaining new loans and debt limits can be encountered; (4) transactions costs (sales commissions) are incurred in selling land and buildings; and (5) building sales are tied to land sales.

Of these assumptions, only those related to utility and returns to scale are significantly restrictive. Nevertheless, these assumptions have been viewed as reasonable approximations of reality in numerous studies and seem to be most general and reasonable approximations for which one could plausibly expect a comprehensive yet tractable conceptual model of land transactions. For example, the assumption about returns to scale permits separability of the land price analysis from commodity price analysis. The assumption about the utility of consumption and wealth permits the decision problem to be modelled as maximizing a mean-variance function of ending wealth plus current returns. The other assumptions are as general or more general than those used in previous studies.

A few comments regarding the general model structure can serve to motivate the framework. First, farming is viewed as risky both in terms of operating income (output prices and yields) and wealth accumulation (land prices). Neither farm income nor land price appreciation usually turn out as anticipated. Also, government policies are occasionally revised with unanticipated consequences. In this economic environment, farmers cannot make long run decisions with certainty. Production plans and investments portfolios often must be altered because of unexpected events. For this reason, this study emphasizes decision making in the short run. The farmer's objective is assumed to be expressed in terms of consumption and wealth accumulation over the short run. Decisions are frequently altered to meet these short-run goals as economic conditions change.

This approach sacrifices the formality of closed-loop dynamic programming or optimal control (used by Shalit and Schmitz) because it is impossible with a stochastic environment. Rather, an open-loop stochastic optimal control approach is adopted with a one period planning horizon decision rule (Rausser and Howitt, 1975). This rule is viewed as appropriate here: (1) because economic conditions are highly unpredictable over longer horizons in land markets, thus

reducing the relative benefits of sophisticated decision approaches; (2) because few farmers possess or employ the resources necessary for highly sophisticated dynamic decisions rules; (3) because observed conditions whereby farmers have been poorly suited and slow to respond to wide swings in land markets suggest more naive decision rules; and (4) because a simple decision rule is more tractable and thus, in view of other considerations, leads to a more instructive abstraction.

A detailed derivation of a land price model under the above assumptions is beyond the scope of this paper. Suffice it to say that solving for first order conditions in individual farmer's decision problems under the above conditions, assuming joint normality of returns to farming and land prices, aggregating over farmers facing heterogeneous boundary conditions, and solving a land market equilibrium equation for land price results in the following (see Just, 1988):

$$\bar{p}_t = f_t \frac{\rho(1 - \tau_t \upsilon_t \psi_g)\bar{P}^*_t + (1 - \tau_t)\bar{R}^*_t - \beta\phi^{2^-}A\Sigma_t}{1 - \tau_t \upsilon_t \psi_g + \gamma_t (1 - \tau_t) + \psi_s Z_t + \varphi_t - \psi_d f_t (1 - \Delta)Z_t} \quad (1)$$

where :

$$Z_t = - (1-\tau) [\gamma_t - r_t - (1 + \gamma_t)\Delta]/(1-\Delta)$$

$$\Sigma_t = (1 - \tau_t \upsilon_t \psi_g)^2 p^2 \omega_t + (1-\tau)^2 \sigma_t + 2(1 - \tau_t \upsilon_t \psi_g)(1- \tau_t)\xi_t,$$

the variables are:

$\bar{p}_t$ = average land price at the beginning of period t

f_t = 1 plus the current rate of inflation at time t

τ_t = the average tax rate on current income

υ_t = the proportion of capital gains taxed in period t

$\bar{P}^*_t$ = average land price expectation for the end of period t held at the beginning of period t

$\bar{R}^*_t$ = average expected net returns to farming per acre including government programme payments for period t

$\bar{A}_t$ = average farm size in period t

Σ_t = perceived variance of end-of-year wealth per acre about expectations

γ_t = rate of interest earned on savings in period t

r_t = rate of interest paid on debt in period t

Z_t = effective cost of debt

φ_t = property tax per acre on real estate in period t

ω_t = perceived variance of end-of-year land price about beginning-of-year expectations

σ_t = perceived variance of net returns from farming per acre including government programmes around expectations

ζ_t = perceived covariance of land price and net returns per acre,
the unknown parameters are:

β = coefficient of absolute risk aversion on profit

$\phi = \beta*/(\beta* + \beta)$ where $\beta*$ is the coefficient of absolute risk aversion on short-run variations in wealth:

ρ = 1 minus the rate of sales commissions on land transactions

Δ = rate of finance charges and other transactions costs on new debt, and
the indicators of strength of various regimes and phenomena are:

Ψ_g = proportion of current land value attributable to capital gain

Ψ_s = proportion of farmland in farms with a binding minimal savings constraint

Ψ_d = proportion of farmland value financed by debt.

While equation (1) appears rather complicated, the intuition is straightforward. First, if all the complications of inflation ($f_t = 1$), taxes ($\tau_t = 0, \varphi_t = 0$), credit market imperfections ($\gamma_t = r_t$), transactions costs ($\Delta = 0, \rho = 1$), and risk aversion ($\beta = 0$) are eliminated from this model, then this equation reduces to the standard discounting equation

$$\bar{p}_t = \frac{\bar{P}*_t + \bar{R}*_t}{1 + \gamma_t} \qquad (2)$$

which in equilibrium ($\bar{p}_t = \bar{P}*_t$) yields $\bar{p}_t = \bar{R}^*_t/(\gamma_t)$.

Adding simple inflation considerations multiplies the right hand side of equation (2) by f_t obtaining $\bar{p}_t = f_t (\bar{P}_t + \bar{R}^*_t)/(1 + \gamma_t)$ which in long-run equilibrium reduces to the same basic equation as does the model developed by Feldstein. All of the additional effects in equation (1) are justified as a modification of this equation. To see this, note that the numerator represents the value of holding an acre of land while the denominator represents the opportunity cost of channelling a dollar's worth of wealth into land. In this context, the terms in equation (1) can be examined and interpreted one by one.

The first numerator term is the expected value of land after appreciation. It must be discounted by the transactions costs eventually incurred in selling land and by the taxes that must be paid on the capital gains. The latter are affected by the capital gains tax break if it applies. The second numerator term is the value of holding land attributable to farming including government payments. It must be reduced by the tax rate on farm income. The third numerator term is a discount for risk incurred in farming and holding farm land. Since ß is a coefficient of absolute risk aversion, the risk is expressed in absolute terms which makes it depend on average farm size.

Turning to the denominator, the first term represents the direct opportunity cost of a dollar used for investment just as in equation (2). The second denominator term represents the tax break that holders of land receive by not

being taxed on appreciation until land is sold. In contrast, interest on savings creates a current tax liability which reduces the amount on which interest can be earned in the following period. Relative to savings, this tax break is reflected by lowering the cost of a dollar invested in land by the proportion of the tax liability per dollar of land value held. The reduction of the opportunity rate of return on savings, γ_t, by the rate of income taxes incurred on that return is reflected in the third denominator term in (1).

The fourth denominator term represents the higher cost of borrowing including transactions costs that must be incurred by individuals that do not have sufficient savings to finance land purchases. The fifth term is the rate of real estate taxes incurred on a dollar invested in land which effectively increases the cost of investment in land. Finally, the sixth denominator term represents the effect of credit constraints on the opportunity cost of money invested in land. As the credit constraint becomes binding, the opportunity cost of money rises. Note that the debt-asset ratio credit limitation, μ, is reflected in ψ_d. For example, if all farmers were constrained by debt then $\psi_d = \mu$.

Estimation of the model

To estimate the model in equation (1), cross-section/time-series data from the Economic Research Service of the United States Department of Agriculture were used. Data were available for states for 1950 to 1984 on land value, acreage in farms, number of farms, real estate debt, real estate tax rate, net returns per acre to farming with and without government programme payments, interest rates, taxes, and inflation. The index of prices paid by farmers for all items was used to compute a rate of inflation (f_t is the current value of the index divided by its lagged value). The average interest rate on farm real estate was used to represent the interest rate on debt. The interest rate on municipal bonds was used for the interest rate on savings (note that the treasury bill rate has a serious discontinuity at 1973 which prevents its direct use). An average tax rate was computed by dividing personal tax and nontax payments of farms to government by total personal income of the farm population. The proportion of capital gains taxable is .4 for the entire sample period.

Data for the indicator variables are not directly available in some cases but reasonable proxy variables are available. The proportion of farmland financed by debt is reflected by the ratio of total debt to the value of all farmland. The proportion of farmland in farms with minimal savings is roughly the same as the proportion of farmland in farms that use debt financing, assuming interest rate differentials induce land holders to retire debt if excess savings are available. The latter proportion can be approximated by the ratio of total debt to total debt capacity, $\psi_s = D_t/\mu p_t A_t$. Finally, the proportion of current land value attributable to capital gain is the ratio of current land value to land value at the time of last purchase. This ratio is unobservable but is approximated by the ratio of expected land value to lagged land value in nominal terms. A seven year lag was used but the results are not very sensitive to lengths of lag beyond five years which seems sufficient to capture reality as an average time of ownership.

Using these data for a set of states comparable to the previous study by Alston, several alternative regimes for expectations on land prices and returns per acre to farming were examined. These included rational, adaptive, extrapolative, and naive. Rational expectations were developed by regressing actual prices and returns on available explanatory data and using the predictions. Adaptive expectations were specified following a geometric lag structure. Extrapolative expectations were developed by extending a four year trend. Lagged values were used for the naive case. The variances and covariance of actual land prices and returns about these expectations were also computed. Somewhat contrary to the flood of literature on rational expectations, estimation of the model with these alternatives showed that a better fit was obtained with naive expectations (see Just, 1988, for the details). Thus, all of the results reported here are for the naive expectations case.

Now consider estimation of the remaining parameters. Preliminary estimation led to much less precision on estimates of the transactions costs parameters Δ and ρ than extraneous information suggests. For these parameters the values $\Delta = .02$ and $\rho = .94$ were simply imposed. Again the results were not very sensitive to changes in these assumptions within a realistic range of $\pm.02$. Real estate transactions typically incur sales commissions of 6 per cent give or take 1 or 2 per cent. New debt financing typically incurs finance charges in the neighbourhood of 2 points give or take a point. Compared to this information, unconstrained estimation incurs substantial errors with broad standard deviations. The remaining parameters, β and $\emptyset$, appear together, so only 1 parameter remains to be estimated in fitting equation (1) to the data.

While only one parameter remains free, comparison with other studies shows that the model is capable of a remarkably close fit of actual data. For example, estimation of the model over the same states and years as used by Alston led to a higher R^2 (allowing a separate risk parameter for each state) even though Alston used a free form distributed lag with 13 lag parameters and 16 overall parameters with 20 years of data (Just). Thus, given that the variables in this model also have a plausible theoretical relationship, at least a comparable level of confidence can apply to the resulting analysis.

The empirical results

For the purposes of this paper, four states were chosen to represent a broad cross-sectional view of the US. Iowa was chosen to represent the corn belt, Kansas to represent the wheat belt, Arizona to represent irrigated agriculture in the Southwest, and Georgia to represent the Southeast. Data for the period 1963 to 1982 were used for estimation. Data for 1983 and 1984 were used to validate the model and fit the predictions very closely. The model was estimated by the nonlinear seemingly unrelated regression (SUR) method to take advantage of the high correlation of disturbances that exists among states. First-order autoregressive disturbances were assumed since serial correlation of the disturbances was significant.

The results are presented in Table 1. The R^2 statistics are lower than were obtained with nonlinear least squares while the t-ratios for the estimated coeffi-

TABLE 1   *The estimated four-state land price model*

Coefficient	Iowa	Kansas	Georgia	Arizona
1000 $\beta\emptyset^2$	.2419	1.1915	2.2347	.0768
	(.0948)[a]	(.2841)	(.4692)	(.0318)
Autocorrelation	.5575	.5405	.6728	.3558
	(.2158)	(.1448)	(.0160)	(.0184)
R^2	.9152	.8573	.9469	.7066

Note: [a]Numbers in parentheses are estimated standard errors.

cients were over twice as high in some cases as a result of using SUR. The estimated autoregressive parameters are quite high and very significant indicating extremely low order noise in the disturbances.

The estimated coefficients of the model are significant statistically, indicating that risk aversion plays a role in land price determination. Barry (1980) also examined the extent to which land prices embody a risk premium and found little effect. While the results here seem at odds with his conclusion on the surface, the magnitude of the effect of risk on prices here is also quite small during the time period of analysis used by Barry (1950–77), even though the statistical precision is high. On the other hand, the magnitude of risk effects are quite strong in some areas of the country in the 1972–80 period as shown below, so apparently Barry's conclusions may be no longer applicable.

Decomposition of price movements

To understand the source of land price movements, this section decomposes predicted annual land price changes among all of the effects represented in the model in (1). That is, the price changes are decomposed according to the effects represented by the various terms of the numerator and denominator. The decomposition of predicted price changes is reported in Table 2 by effect for the years of land price volatility, 1973–84. Due to the very similar results for each state and in the interest of saving space, the decomposition is reported only for Iowa. The net returns variable is divided into components of market returns to farming and government payments. The reader should bear firmly in mind that the inflation effect is the effect of inflation on real prices rather than on nominal prices so the effect of inflation on the numeraire is already removed. The predicted price change and its various components are reported in real 1910–14 dollars which for 1980–1 differed from current dollars by a factor of about 10.

The results show that some variables are uniformly unimportant while others are often important. Land price expectations are the most important annual explanatory force in every state although price expectations are not an important explanatory force in every year with a large predicted change. Note, however, that the change in land price expectations is explained by changes in previous prices and, thus, indirectly by previous changes in other variables. That is, with naive expectations, the change in price expectations for period t is explained by the change in price expectations and all other variables in period t-1, the change in price expectation in period t-1 by price expectations and all other variables in

TABLE 2   *Decomposition of predicted real price changes by effect for Iowa, 1973–84*

Year	Total Predicted Change	Expectations			Risk	Defer Gain Taxes	Opportunity		Land Tax	Credit Limit	Inflation
		Price	Farming	Govt.			Saving	Debt			
1973	23.20	−0.35	2.35	0.78	0.33	−0.39	9.84	−0.01	0.18	0.05	8.94
1974	−13.97	−2.91	8.27	−1.13	0.05	0.09	−3.16	0.20	0.32	−0.19	−2.03
1975	3.34	12.10	−6.40	−0.99	−0.25	0.69	−4.77	0.10	0.08	−0.10	−4.12
1976	9.97	9.62	−0.14	0.16	−1.56	0.64	−2.98	−0.05	0.08	0.03	−3.63
1977	24.31	22.35	−3.85	−0.12	−5.87	0.91	−0.09	−0.06	0.22	0.05	−1.16
1978	36.40	41.96	0.06	0.00	−29.26	1.08	2.79	−0.03	0.01	0.04	3.33
1979	9.98	−4.93	3.94	1.02	6.97	0.26	7.90	0.05	0.09	−0.02	8.15
1980	−11.72	4.20	−1.63	−0.85	6.70	0.22	−6.56	0.35	0.08	−0.31	−3.18
1981	7.87	11.42	−3.89	−0.10	5.63	−0.07	−7.91	0.04	0.02	−0.35	−4.13
1982	−8.27	−0.27	3.23	0.02	5.94	−0.52	−7.50	−0.10	0.09	0.08	−8.16
1983	29.67	−14.38	−3.45	0.36	−1.93	−1.58	0.30	−0.59	−1.13	0.47	−2.85
1984	−26.91	−17.84	−3.45	1.57	−4.61	−2.15	−0.92	0.14	−0.01	−0.11	−0.08

period t-2 and so on. Thus, the relative role of variables other than price expectations is the primary concern in understanding which forces explain the wide swings in US land prices. The contribution of price expectations in each year is primarily important in understanding the dynamic effects of the other variables.

With respect to the remaining variables, the most striking effect in Table 2 is the dynamic role of inflation and the opportunity cost of capital. These two effects are the primary forces in the 1973 take-off period. In 1973, inflation increased from a 20-year high of 6.25 per cent in 1972 to 15.5 per cent (as measured by the index of prices paid by farmers). This large increase in inflation explains 38 per cent of the 1973 price increase in Iowa. A more detailed analysis of this effect (not shown in Table 1) reveals that essentially all of this effect is simply the direct effect of capital erosion whereby the opportunity cost of a dollar invested in any activity declined because it would be worth 15. 5 per cent (rather than 6.25 per cent) less in real terms after 1 year of use (aside from the rate of return it earns).

The other major force in 1973 is the opportunity rate of return on the capital invested. In 1973, the real rate of return on savings dropped from a 20 year average of nearly 2 per cent and an all-time low of –1 per cent in 1972 to –10.4 per cent. This caused investment in land to become much more attractive by comparison. This effect explains 42 per cent of the predicted land price increase in 1973. Note that the additional effect of the differential rate of interest between debt and savings (represented by the debt column of Table 2) has a minor effect. The reason for the minor effect of the additional rate of interest on debt is that debt is not a very large percentage of land value (17.7 per cent in 1984 was an all-time high for Iowa).

Following the 1973 take-off period, much of the ensuing inflation through 1978 appears to be due to the 1973 effects working their way through the system as reflected by the price expectations effects. This is particularly evident upon recognizing that much of the predicted 1973 price increase did not actually occur until 1974. To understand this explanation, note that an initial price increase due to inflation or opportunity cost has a positive effect the following year on price expectations; these higher price expectations, in turn, cause a higher price the following year which then causes higher price expectations to be transmitted to a third year, and so on. The adjustment process works much like a Nerlovian partial adjustment model. Aside from the boost in expected returns to farming in 1974, the inflation and opportunity cost factors of 1973 are the only major explanatory forces behind the increased price expectations of 1975 through 1978. Furthermore, the predicted price changes follow expectations quite closely during that period.

By 1977, inflation and opportunity cost had returned to their pre-1973 extremes and the remaining high price expectations were simply due to the time lag in the adjustment process. Furthermore, by 1978 in Iowa the land price volatility had led to large increases in perceived risk that also tended to curtail further price increases. As a result, the record land price inflation would have ended were it not for another round of inflationary shocks; actual real prices, in fact, fell by a small amount in 1978 in Iowa, even though the model predicted a smaller continued increase.

In 1979, a second round of inflation caused another wave of effects resembling 1973. Inflation returned to 13.8 per cent and the real return on savings dropped

to –7.4 per cent – essentially the same levels of 1974. Each of these two effects on land prices accounted for about 80 per cent of the predicted land price increases in 1979. In other words, the 1979 price increases due to these variables alone would have been considerably higher if other variables had not had strong moderating influences. The reason that the 1979 shock did not touch off as strong a wave of land price inflation as 1973 was that perceived risk had increased substantially as a result of rapid movements in land prices and that these effects were being reflected in lower real land prices and land price expectations. Furthermore, the inflation and opportunity cost shocks were shorter-lived and quickly reversed.

The model begins to predict the price turn around of the 1980s beginning in 1980. The decline is primarily due to the same inflation and opportunity-cost factors. From 1979 to 1982 the real return on savings increased from –7.4 to 7.4 while the rate of inflation declined from 13.8 to 4.2 per cent. The associated opportunity-cost effect explains about 55 per cent of the 1980 predicted decline for Iowa while the direct inflation effect explains about 27 per cent of the predicted change in real prices.

Although the predicted decline in 1980 did not actually occur until 1981, the negative effects of inflation and opportunity cost on changes in land prices continued to increase until 1982. Effects of these variables in 1983 and 1984 were also negative but of declining magnitude. The negative effects of inflation and opportunity cost on land prices in 1980 and 1981 tended to be moderated by their lagged positive effects from 1979 remaining in land price expectations.

EVALUATION OF COMPETING EXPLANATIONS

Given the prominent role attributed to inflation and opportunity cost by the results here, some comments about competing explanations are in order. The strongest alternative view is that the large land price swings of the past 15 years primarily follow from the capitalized value of returns including government programme payments. First, the results in Table 2 show that government payments are a minor factor in explaining year to year changes in land prices. The reason is that payments per acre seldom change significantly from year-to-year and when they do change they usually only offset a part of larger competing change in market returns to farming. This does not imply that government payments are not important in the absolute level of land prices. Government payments may account for roughly 15 to 25 per cent of the capitalized value of land; but because of their stabilizing tendency, they account for only a small part of fluctuations in land prices.

Next, consider the overall effects of capitalized returns to farming on changes in land prices. Here it is important to realize that returns to farming declined rapidly after 1973 in real terms. In Iowa, real returns including government programme payments were actually lower in every year from 1974 to 1978 than they were in every year from 1963 to 1973 except 1971. (Similar patterns of real returns occurred in Kansas and Georgia as well.) In other words, while conventional wisdom views returns as high following the 1973 commodity boom, returns were only high in nominal terms. Due to high inflation, real returns were

in decline following 1973 and at lower absolute levels than before 1973. In these circumstances, only a peculiar lag distribution with relatively more weight on longer lags than shorter lags can explain the rising prices of the mid 1970s on the basis of changes in returns. (Note that the supporting empirical evidence produced by Alston and Burt estimate such lag distributions using *ad hoc* empirical specifications. We argue that such lag distributions are implausible, ignore the role of opportunity cost and inflation beyond simple discounting of prices, and simply manifest casual correlations in the data.)

Finally, consider the effects of credit availability on land prices. Here the model estimates only minor effects on land prices. The reason is that debt is so small compared to land value (less than 15 per cent in most cases). In these circumstances, it is difficult to imagine that a sufficient share of land transactions were limited by credit to make changes in collateral constraints important in market prices (unless expectations were highly skewed). In this conclusion, the generality of the credit constraint of the model in this paper may be questionable because it does not include cash flow. However, it is the same type of credit constraint as examined in previous land price studies (for example, Shalit and Schmitz, 1982).

CONCLUSIONS

This paper develops a structural model of land prices which includes the multidimensional effect of inflation associated with capital erosion, savings-return erosion and real debt reduction, as well as the effect of changes in the opportunity cost of capital. In spite of the imposition of a substantial *a priori* theoretical structure and extraneous information, the model fits the data well compared to *ad hoc* econometric models. The results show that the large price swings in the US are primarily explained by inflation and changes in real returns on alternative uses of capital. These effects caused substantial appreciation in 1973 and 1979 and substantial depreciation in the 1980s. The large shock of 1973 tended to continue as indirect effects worked their way through land price expectations whereas the lagged effects of later changes only tended to moderate the effects of further changes in the causal variables.

Several shortcomings of the analysis should be born in mind in evaluating the results. First, the expectations mechanisms may be misspecified. The statistical fit was not very sensitive to the choice of expectation mechanism. Changing the expectation mechanism tends to change the rate at which other causal effects are transmitted to future periods but preliminary analysis suggests that the major change is in the estimated autoregressive mechanism. Second, the model tends to estimate turning points one period early (for example, 1973 and 1980). This might be rectified by using a more naive approach whereby lagged inflation and interest rates rather than current values are used in determining land market transactions. Because only one parameter of structure is estimated for each state, this change should lead to little change in the general conclusions even though the timing of some of the predictions would tend to change by one period. The model as estimated here, however, tends to produce very close predictions beyond its sample period. Another alteration that is left to future research is the role of

money illusion that may be driving changes in periods of high inflation. If farmers do not completely discount large land price increases that occur in periods of high inflation such as the mid-1970s, then some of the lagged effects of inflation could be due to money illusion rather than dynamic effects of land price expectations. Again, however, incorporating these modifications should not cause major changes in the conclusions but only in the story of how the indirect effects enter land price changes.

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DISCUSSION OPENING – THOMAS C. PINCKNEY

Proverbs 17:28 says, 'Even a fool is thought wise if he keeps silent, and discerning if he holds his tongue'. Unfortunately, I do not have the option of holding my tongue in this position, so I will have to expose my ignorance of the topic at hand. Since this area is not my speciality, I will play the role of the generic economist and ask three simple questions: First, does the methodology make sense? Second, are the results reasonable? Third, how do the conclusions compare with other statements made at this conference about changes in US land prices?

Now to the first point: methodology. Just and Miranowski present us with an interesting paper on a highly contentious topic. Although it is difficult to discuss methodology in a forum such as this, the results in this paper differ from those of previous studies primarily because of methodology. Therefore we have no choice but to spend some time considering their technique.

One controversial topic is the method of modelling price expectations. Just and Miranowski set out four possibilities: rational, trend, adaptive, and naive

expectations. Since the estimating equation produced the best fit with naive expectations, this formulation was used for the results presented in the paper. Unfortunately, they do not report which of the four produced the best prediction of the next year's price of land, although we can be certain that the rational expectations predictor is superior to the naive predictor on this score.

A second point under methodology concerns the nature of the estimating equation. Just and Miranowski present the first-order conditions both in full form and in a simplified form to make the process easier to understand. Unfortunately, their simplified form is too simple in that by leaving out risk aversion, they dispose of the variable which remains to be estimated in their model. In this equation, I have reformulated the equation with no taxes, no credit market imperfections, no transactions costs, and no inflation but with risk aversion included:

$$\bar{P}_t = \frac{P_t^* + \bar{R}_t^* - (\beta\phi^2)(\bar{A}\Sigma_t)}{1 - \gamma_t}$$

The variable descriptions are on page 759. Verbally, the equation says that this year's land price equals the expected price next year plus the returns to farming next year less a risk aversion coefficient times the perceived variability of the value of an average-sized farm, the quantity discounted by the interest rate. The authors either have data or produce proxies for all variables except the risk aversion coefficients. Isolating these on the right-hand side yields:

$$\bar{P}_t^* + R_t^* - \bar{P}_t(1 - \gamma_t) = (\beta\phi^2)(\bar{A}(W_t + \sigma_t + 2\xi_t))$$

which should be the estimating equation. This is thus a linear regression with the intercept suppressed. The independent variable in the equation is the perceived variability of the average-sized farm, thus highlighting the importance of accurate representations for the perceived variability of the price of land and returns to farming. Yet the authors do not tell us how they calculate these figures. Some enlightenment on this score would be helpful.

Now we move to the second major point by considering whether or not the results are reasonable. Again, there are two subpoints. First, consider the estimated risk aversion parameters presented in Table 1 for four states. Although the coefficient is the risk aversion parameter beta multiplied by phi-squared, if we assume that the risk aversion parameter for profits equals the risk aversion parameter for land values, phi becomes a scalar and the risk aversion parameters are proportional to the numbers estimated in the regressions. But these results are curious. Is there any reason why farmers in Georgia should be 30 times as sensitive to risk as farmers in Arizona, and 10 times as risk averse as farmers in Iowa?

The second point under 'reasonableness of the results' concerns the decomposition of predicted price changes. In Table 2, the total predicted change is decomposed into nine components. Unfortunately, the nine components do not add up to the total predicted change. Moreover, in many years the difference is quite large. For example, for 1974 the total predicted change is −13.97 but the sum of the components is −0.49. Similarly, for 1979 the total predicted change is 9.98 but the sum of the components is 23.43. Is there a residual that has been left out?

If so, the residual is a more important determinant of land prices than any of the components included in the table, casting some doubts on the value of the analysis. Are these differences the result of the autocorrelation parameter? If so, how are we to interpret this influence on land prices? Some clarification on this would be helpful.

My third and final major point concerns the relationship of this paper to others presented at the conference. At least two earlier papers have made statements regarding the increase in US land prices in the 1970s. Drabenstott and Barkema state that 'The 1970s became an unqualified success for US farmers. Farm incomes were record high. The high incomes, and expectations that incomes would move even higher, fed a rapid increase in farmland values.' Although they acknowledge that inflation and interest rates had effects, their main emphasis seems to be on returns to farming. Ed Schuh's paper includes a similar phrase, and Lyle Schertz's comments from the floor yesterday on the Drabenstott and Barkema paper emphasized the importance of returns to farming for future land price increases. On the other hand, Just and Miranowski state that real returns to farming declined following 1973, and that 'only a peculiar lag distribution with relatively more weight on longer lags than shorter lags can explain the rising prices of the mid-1970s on the basis of changes in returns to farming'. There is clearly a lot to discuss here.

In sum, Just and Miranowski present an interesting and rigorous analysis of the changes in US land prices over the last 15 years. This generic economist has benefited from their analysis, and I trust that the discussion to follow will answer the few points I have brought up, and clarify the thinking of all of us regarding this controversial topic.